Map Maker

Version 1.0

The Map Maker Manual

Map Maker Version 1.0

for Microsoft Windows 3.1 and Windows for Workgroups 3.11

1st January 1996

Map Maker has been designed primarily for development projects in developing countries though it has proven to be of use in a wide range of other fields, notably archaeology and environmental monitoring. It is being made available for free or at cost to non-profit making institutions, students and academics. These users are encouraged to copy both the software and the documentation and pass it on to others. Those that can afford to pay something, institutional users particularly, are encouraged to send contributions to the author so that we can continue to disseminate software and documentation to those users with less resources.

First printed: January 1996

The picture used for the *Map Maker* logo is taken from a woodcut done by Albrecht Durer to illustrate his book the *Art of Mensuration* in 1525.

Note on copyright

The prototype version of the software was put on the Internet in April 1995 and before the end of 1995 more than 600 people in 45 countries had registered their copies. Thanks to the patience and valuable feedback from many of these early users, the prototype evolved to the point were the definitive version 1.0 of *Map Maker* was released in December 1995. In January 1995 a draft manual was produced for the prototype software. In August 1995 draft training notes were produced. This manual partly incorporates and supercedes both the training notes and the earlier manual.

A volume of structured training notes suitable for use in courses is available in Spanish. Anyone interested in this should contact the author.

The development and dissemination of the software to date has been funded by the author. A grant from the World Conservation Union (IUCN) and Canada's International Development Research Centre (IDRC) contributed towards the production costs of this manual. Future developments of *Map Maker*, supporting documentation, training, and specialist user groups are dependant on raising additional funds.

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1. Introduction

Map Maker is a simple Geographical Information System (GIS) designed to allow non-expert users to create and manipulate maps on basic personal computers. Using a variety of tools you can navigate around the map, measure distances and areas, draw polygons, lines and symbols, and display and edit data. *Map Maker* can print maps directly on to any printer or plotter supported by *Windows 3.1* or can export images for inclusion in documents produced on compatible *Windows* word processors, such as *Microsoft Word, Word Perfect,* and *Lotus Ami-Pro.*

1.a. Tips

Tip: *To learn (a little) about the function of any menu item, hold the "Shift" key down and click on the menu item.*

Tip: *Clicking with the right mouse button while drawing a line or polygon or making a measurement finishes the operation, otherwise it brings up the "Fast menu" of commonly used tools and functions.*

1.b. Summary of key features

- ***Drawing***. There are a range of easy to use drawing tools which allow you to produce freehand maps, work with an on-screen grid, or trace over existing images. The tools permit you to draw polygons, lines, and symbols. You may, if you wish design your own symbols. In addition to drawing simple objects, there is also support for "node and link" drawing which allows for cellular networks to be created and edited.
- ***On-screen measurement***. Distances, areas, and angles can be easily measured on screen. Distances and areas can be in metric or imperial units.
- ***Raster and vector layers***. Both raster (scanned images) and vector images are supported. Maps can be built up of layers and raster and vector images can be mixed.
- ***Links to databases***. Values in databases can be linked to objects on the map. The objects can be coloured according to the values and the database can be interrogated by clicking on the object. New databases can be created from the map and edited with the map.
- ***Importing from other systems***. Graphic data from all other common GIS systems can be imported into Map Maker.
- ***Exporting to word processors***. Images can be exported from Map Maker as "Windows metafiles" which can be used as pictures in documents produced by Windows word processors such as *Word, Word Perfect for Windows,* and *Lotus Ami Pro.*
- ***Page layou***t. Apart from producing the basic map, you can easily add title blocks, text panels, north points, scale bars, and legends (or keys).
- ***Poster prints***. Large wall maps can be produced on conventional printers using A4 or letter sized paper by choosing the poster print option which prints maps out on several sheets (up to 100 sheets). Using this facility wall maps can be produced in the field using a low-cost dot-matrix or ink-jet printer.
- ***Field surveys***. Numerical data from field surveys can be used to create drawings directly without the need for complex trigonometry and other calculations. Map Maker can also help you to make simple, virtually zero-cost surveying instruments using your printer as a manufacturing tool.

- ***Data modelling***. At the other extreme, you can carry out sophisticated spatial data modelling using data surfaces generated from point data. Using this technique different data sets may be combined to examine how one or more variables relate to other variables.
- ***Customisation.*** Map Maker can be customised to produce a hypertext educational package of text and maps.

1.c. System requirements

Map Maker will run on any computer running *Microsoft Windows 3.1* or *Windows for Workgroups 3.11*. In practical terms this means a computer with at least a 386 processor (preferably 486) with a minimum of 4 megabytes of RAM (*Map Maker* will work on a 386 with 2Mb of RAM but it is very slow and may crash during memory intensive operations such as when using scans). *Map Maker* requires about 1.4 megabytes of disk space, though as with all other *Windows* applications it is wise to maintain at least 5 megabytes of free disk space to cope with the temporary files which *Windows* creates.

Map Maker runs perfectly well on laptop computers. Clearly, a colour screen is preferable but it can work perfectly well on a mono screen. Many laptops are fitted with a trackerball or some other integral pointing device. These are often awkward to use for graphic operations such as drawing and measurement. Laptop users are advised to use a conventional mouse. Most laptops have a socket where a mouse can be plugged in.

Before using *Map Maker* you should be reasonably familiar with *Microsoft Windows*. If you are new to *Windows* you are advised to read one of the many available beginners guides to *Windows* and to run the Windows tutorial which is included under the "Help" file of the *Windows* "Program Manager". You should also be familiar with the DOS conventions of directories and file names.

Map Maker is designed for "standalone" systems (individual computers) rather than for use on networks. Where it is used on a network only the data should be shared. Each computer should have its own copy of *Map Maker*. The program has been kept so small that space should not be a problem.

1.e. Installation

The installation procedure varies slightly depending on whether you have an installation diskette or whether you have downloaded the compressed version of *Map Maker* over the Internet. If you have the compressed version you should put the file MMZIP.EXE in a temporary directory and then "run" MMZIP.EXE. To run a file either double click on it in the File Manager or else in the Program Manager go to **File - Run** and enter the full name of the program with its directory. MMZIP is a self-extracting compressed file so that when it is run it will unpack a number of files. One of the files unpacked is called INSTAL.EXE, this file should now be run.

Alternatively, if you have a version on diskette, put the diskette in your A drive (or B drive) go to the Program Manager, click on **File - Run** and enter `A:\INSTAL` (or `B:\INSTAL`).

A dialog box appears asking for two things: the name of a directory in which the program should be installed (by default `C:\MAPMAKER`) and the name of a Windows "group" which should be created for the *Map Maker* icons. By default the group name is "Day to day", this is to encourage users not too familiar with windows to put copies of the icons for the programs they use most into one group. Click on OK and the installation procedure will be completed. If you are installing from the downloaded compressed version you can delete the files from the temporary directory.

If you already have *Map Maker* on you system and you wish to update it, simply follow the same procedure.

1.e. Map Maker on Internet

The latest version of *Map Maker* in compressed form can be downloaded over the Internet either using FTP or via the World Wide Web. The addresses are:

http://www.ibmpcug.co.uk/~MapMaker/

or

ftp.win-uk.net/pub/users/MapMaker/mmzip.exe

In addition to the program there are also at these sites some demonstration files, base maps of many countries, and documentation.

1.f. Mail order

A copy of this manual with the latest version of the program on diskette are available by post for free (while stocks last) to non-profit making institutions, academics, and students but those who can afford to pay are requested to send a contribution of a minimum of US$ 25 or £15 as a cheque drawn on either a US or British bank or else as an International Money order. The more people that can pay the more that can receive help for free. To receive a copy please send your name, postal address, and if possible payment to:

Eric Dudley
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If you send a payment please indicate if you need an invoice.

2. Twelve key concepts

1. ***Layers.*** A map is built up of layers. Typically, each layer will describe a different theme, such as boundaries, roads, rivers, services, etc. A layer is usually either a drawing file (.DRA) containing co-ordinates of objects such as polygons, lines, and symbols or else an image made up of dots produced on a scanner (.TIF or .BMP). There are other types of layer available such as "Location" files (.LOC) which are simple comma separated text files and data surfaces (.SFC) which describe how a data variable changes over the extent of a map

2. ***Objects***. In *Map Maker*, the word "object" is always used to refer to a geometrical object such as a polygon, line, or symbol which is located at a particular geographical place. These objects are represented on the map. As maps of different scales or extent are drawn so the position of objects which are fixed in space move relative to the page.

3. ***Scans.*** A scanned image is like a photograph in a newspaper, it is simply a collection of black and white (or coloured) dots which go together to create an image. It does not contain information about individual objects it just describes a picture. They are useful for providing a background over which drawing layers can be placed. In *Map Maker* the industry standard TIFF (Tagged Image File Format) and Windows Bitmaps (BMP) formats are used. Only black and white (sometimes known as "one-bit") TIFF images are supported while BMP files may be shown in full colour. Scanned images (sometimes known as bitmap or raster images) can be produced from paper maps, sketches, or photographs. If you do not have access to a scanner a fax machine can be used to send a scan to a computer with a fax modem. Scans can be a useful starting point for making a map since you can trace over the image on the screen. With scans, particularly, care should be taken not to infringe any copyright on the maps.

4. ***The live layer.*** Sitting on top of the map layers is the so-called "live layer". The live layer is where new objects are drawn and existing ones are edited and deleted. The contents of the live layer can be saved to a file and existing files may be loaded into the live layer. By loading more than one file into the live layer files may be merged.

5. ***Scale***. The concept of scale can cause confusion. It is a concept important to understand for entering data and calibrating images. The scale of a map is the relationship between dimensions on paper and on the actual ground - in other words if a distance between two points on a map measures 10mm while on the ground it is 500 metres then the scale is 1:50,000 since 10mm goes 50,000 times into 500 metres. Where *Map Maker* refers to scale it is always in relation to the printed page not the screen.

6. ***Display styles.*** The appearance on screen and the printed page of the objects that are contained in drawing files is governed by display styles. Every object has a style number between 0 and 100. You can manually change this number or else it may be governed by values from a data file. This number is used to select a display style from a set of 101 display styles stored in a style file (.STL). There can be any number of style files and each style is user definable. The way the object appears on the screen and on the page is thus governed by the *combination* of the style number attached to the object and the style definition contained in the style file

7. ***Map furniture***. In contrast to "objects", items of map furniture are located with reference to the page or the screen rather than the geography. There is a variety of types of map furniture, including scale bars, north points, title panels, inset images, etc. Map furniture is usually used for general information relating to the map as a whole rather than being tied to particular objects.

8. ***Map assemblies.*** A Map assembly is a collection of all the things which go together to make a map such as layers, data files, captions, scale bars, north points, and page margins. The

components of the Map assembly are held in a Map file with a .MAP extension. When a user loads a MAP file *Map Maker* automatically loads all the components and sets up the screen according to the information contained in the MAP file.

9. ***Tools.*** The tool selected at any one moment determines what the user may do with the mouse, including such things as drawing objects, measuring distances and areas, zooming in, and selecting part of an image to capture and place in a word-processed document.

10. ***Data linking.*** Either using *Map Maker*'s own data editor or else another program such as *Microsoft's Excel* or *FoxPro* data files can be created which can be linked to drawing files. The display style for each object is then selected according to a data value. Using data linking a single base map can be displayed and coloured up in a variety of ways to indicate different types of information. Data can also be used to generate continuous three-dimensional data surfaces, these surfaces may be merged to create composite surfaces in order to create different models of spatially related data.

11. ***Navigation.*** There are several different ways of moving around the map and changing the scale: you can zoom in and out, pan across the map, go to a grid reference, and centre the map on an item in an index file.

12. ***Importing data***. One of the main problems with all mapping programs is where to get the data. Map Maker offers a wide range of techniques for entering data including importing data from other programs, importing data from commercial data suppliers, and converting numerical field survey measurements into maps. For those with access to Internet the Map maker site on the World Wide Web provides links to a number of sources of data.

3. Scale

The scale of a map is simply the relationship between a distance on paper and the corresponding distance on the ground. Often maps are printed without a numerical scale, sometimes they just have a scale bar. Other times a map may be copied and reduced on a photocopier (assuming copyright permission has been obtained) so that the numerical scale is no longer valid. In these cases one can determine the scale by the following process:

Measure a distance on a scale bar - say 5 miles.

If your measurement was in millimetres (say 11.5mm), then first convert the distance on the ground (5 miles) to the same units. There are 25.4mm to the inch and 63,360 inches to the mile so 5 miles = 5 X 63360 X 25.4 mm = 8,046,720

Divide the distance on the ground by the distance on paper, i.e. 8,046,720/11.5 = 699,715
This is the scale of the map. (Note that strictly speaking, the scale of the map is 1/699,715)

If there is no scale bar on your map, as in the case of an aerial photograph, you will need to measure an actual distance on the ground, or maybe measure the corresponding distance on another map.

Scale on paper

In Map Maker there is always in the bottom left of the screen an indication of the "scale on paper". This scale is dependent on four things:

- The size of the paper (set in Printer set up)
- The orientation of the paper (portrait or landscape set in page set up)
- The size of the margins (set in page set up)
- The extent of the map on the screen

When working in "screen view", Map Maker assumes that you want to print the full extent of what is on the screen. Thus it calculates the distance on the ground that corresponds to the total extent of the map from left to right on the screen. This distance (the true distance on the ground) is then divided by the width of the paper minus the left and right margins - this gives the scale.

For this reason, any operation that changes the margins, changes the paper size or orientation, or alters the extent of zoom will alter the final scale on paper. If you want the map to print out at a specific scale you can use **Navigate-Zoom** to set the scale, then Map Maker will make the necessary adjustments taking into account the paper size, margins, etc.

4. The view

Depending on whether you are preparing maps for export as files or to print directly, you can choose different ways to view the map - either page view or screen view. If you are printing directly you will probably want the page view option so that you can see how the maps fits onto the page. Using the **View** menu choose **Page preview**.

If you are preparing maps to export as Windows Metafiles (WMF) the shape of the page is no longer important, rather you will be concerned with the best shape for the map for the data it contains (i.e. a tall thin country does not suit a low wide rectangle) or else the available shape in whatever report the image is designed for. Using screen view options on the **View** menu you can either choose to use the **Full screen** or else choose **Shape to aspect ratio**. The aspect ratio of a rectangle is the ratio between width and height thus a rectangle with an aspect ratio of 1:1 will be square while an aspect ratio of 2:1 will give a rectangle twice as wide as it is high. By selecting an aspect ratio you can create a screen shape suited to the image you want.

When in screen view mode you can still print direct to the printer. In such a case *Map Maker* will print an image in the same proportions as the image on the screen to the biggest size allowed by the paper size and the margin settings.

The **View** menu allows you to alter three further elements influencing the display:

- **View lines symbols and text...** If text and symbols are designed to be a sensible size when printed on paper they can often be too small to read when displayed on screen. *Map Maker* thus offers you two options: either to size lines, symbols and text for the page or for the screen. When you are editing maps you can size these elements for the screen so that you can read them, but if you want an exact page preview you can choose to size for the page.
- **Screen pixels per mm.** In the display styles, line widths, symbol sizes and text sizes are specified in millimetres on the printed page. When you are viewing the map on the screen and sizing these elements for the screen there needs to be a scaling factor which determines how many pixels (dots) on the screen will represent one millimetre. Typically something between 3 or 4 will give a sensible result but this is a matter of personal preference.
- **Grid.** You can choose whether or not to have a grid on the map and if so the spacing of the grid. There is also an **Auto** option where *Map Maker* will automatically choose a sensible grid spacing for a given scale. The colour of the grid is also user-definable.

5. Navigation

There are several ways of navigating around the map. Simple panning and zooming can be done by using the buttons in the lower right of the screen. The **Navigate-Zoom** menu offers the additional option of zooming to a specific scale for the currently selected page size and margins.

In addition to simple panning and zooming their are two other navigation techniques:

- **Go to grid reference.** All maps in *Map Maker* use a grid reference system measured in metres (or yards, feet, or chains) with north at the top. You can specify a grid reference and *Map Maker* will centre the map on that spot.
- **Index.** Any DRA or LOC graphics file can also be used as an index file. By loading a file as an index you can select any object in the file and then *Map Maker* will centre the map on the object. For instance if you had a DRA file containing all the towns in a region which was used as a layer in map it could simultaneously be used as an index. So by selecting that index and selecting a town the map would automatically be adjusted to be centred on that town.

6. Layers

Normally, you will be producing maps with a number of layers, each layer being dedicated to a particular theme, such as roads or water supply. Each layer is stored on disk as a graphics file. The first layer at the bottom of the pile of layers is known as the base layer. To load the base layer open the **File** menu, click on the second item, **Open**, and choose a file from the dialog box which appears. On the left there is a box that says "File types", offering you the choice of layer type: map assemblies (.MAP) drawings (.DRA), scans (.TIF), scans (.BMP), locations (.LOC), DXF, and data surfaces (.SFC). A Map assembly is a complete map consisting of various components. If you want to construct a new map choose from one of the other formats, select the directory where your data is stored, and then select your file. The file will be loaded onto the screen.

Typically, the base layer will be a general map providing the context against which the other layers can be seen. When the first layer - the base layer - is loaded, *Map Maker* adjusts the scale and the co-ordinate system to make sense for this first layer. Subsequent layers can be added by opening the **File** menu and clicking on the second item which will now read **Add layer**.

6.a. Layer types - vector and scan

Map Maker, like most other GIS programs, uses two kinds of graphic files "vector" files, and "scanned" (or bitmap or raster) files. Vector files are often described as potentially "intelligent" since they describe spaces and shapes to which data can be attached while scans are simply patterns of light and shade.

Vector graphics

In *Map Maker* the vector information is usually stored in "drawing" files with a .DRA suffix. A DRA file consists of descriptions of geometrical objects in terms of their X,Y co-ordinates. (The format of DRA files is available to any third party developers in Appendix 1. Vector information can also be used in the DXF (Data eXchange Format) which is widely used in other programs and which was originally developed for AutoCAD. A DXF file may be viewed directly by choosing it as a layer but it will be relatively slow to load. If you are going to regularly use that file you are advised to convert it to a DRA file using the **Import file** utility under the **Utilities** menu. DXF files can contain three-dimensional data and other more obscure items. This data will be ignored by *Map Maker*.

A third vector format is the "Location" file, with a LOC suffix. A LOC file is a simple text file in which the first line describes the structure of the data and each subsequent line describes a location. For each location there are three vital pieces of information: a unique identification name (the ID) and the X and Y ordinates. A simple LOC file might look like:

```
ID,x,y
point 1,1220.5,657.3
health centre,1324.1,543.7
point 2,1132.7,477.3
```

Such a file can easily be produced from a text editor, word processor or database. To describe polygons and lines each XY pair is on a separate line, the sequence being terminated by a line starting with the word "end". For instance:

```
ID,x,y,caption,patients,cost
Hospital 1
123.45,343.55
128.00,322.65
100.12,322.00
```

```
101.67,344.78
123.45,343.55
end,District hospital,54,12000
```

In this instance the last XY pair is the same as the first so Map Maker assumes that the object is a polygon. Note that in this example the LOC file is also being used as a data file.

If a string (a name) contains a comma the whole string should be enclosed in quotation marks.

Scanned (or bitmap or raster) graphics

Scans are like photographic images made up of black and white dots. Scanned images used by Map Maker are stored in the industry standard TIFF format (Tag Image File Format) with a .TIF suffix or as a Windows bitmap (BMP).

The easiest place to start creating a map in *Map Maker* is with a scanned image taken from an existing paper map or aerial photograph, though care has to be taken not to infringe any copyright laws. Where copyright is an issue individual users should negotiate copyright agreements with their data suppliers. Desktop scanners capable of scanning A4 sheets are now relatively cheap. Hand held scanners are also available and can be used but their price advantage is rapidly disappearing. There are many scanners available and also many examples of scanning software. Scans can also be prepared by desktop publishing bureau companies. Scans can be prepared for *Map Maker* on Macintosh computers so long as they are exported to MS-DOS format. Fax machines can also be used to scan an image and send it to a computer with a fax modem.

Generally scans should be prepared as *one-bit uncompressed TIFF* files. Many scanners now offer as standard 600 or 1200 dots per inch (dpi). While this fine resolution can be useful it is often too fine. An image which is too fine takes up enormous amounts of disk space and is unnecessarily large when viewed on the screen. Remember that a VGA screen is 640 dots across thus if an image is scanned at 600 dots per inch only about an inch of the original map will be visible on screen unless you zoom out. Generally 300 or 150 dpi is sufficient. If the original image has greys (such as a photograph) then the scanning software should be capable of "dithering" the image, meaning that it generates patterns of dots to simulate the range of greys.

Where colour images are required Windows Bitmaps (BMP) files should be used. While the TIFF files used by Map Maker are "one-bit", in BMP format any number of bits may be used from one to 24 thus colour images may be produced. However, colour images are often quite hard to use as backgrounds if you intend to do any drawing on top. Colour images also take up a large amount of disk space so generally they should be avoided.

6.b. Adding a drawing (DRA) file as a layer

If,, when adding a layer, a .DRA file is selected you will be presented with a dialog box asking for three characteristics of the layer to be specified:

- *Can you hit it? If* you check the box labelled "Make layer hittable" it means that when the layer is displayed you can use the "Data query" tool to click on any object in the layer and retrieve any information attached to that object.
- *Which display style file?* Each layer will be coloured up according to the display styles attached to the layer. There are 101 styles defined in each style file. The name of a default display style file is automatically entered but you can choose another style file if desired.
- *Style according to what?* There are five choices to how the layer should be styled:

- *Internal default style.* Each object in the drawing file has a default style number ranging from zero to a hundred. This number is entered when the object is created or when it is subsequently edited. If these internal default style numbers are used then, for each object, that number will be used to select the corresponding style from the style file.
- *All one style.* If this choice is selected you can choose one style from the list of styles in the style file and this single style will be applied to all the objects in the layer.
- *Attach data to query.* If you click on this selection you will be asked to name a data file to attach to the layer. Subsequently the contents of the data base for a given object can be interrogated by clicking on the corresponding object on the screen. The internal default styles will be used to determine the style in which the objects are drawn.
- *Styles from External data.* Fourthly, the objects can be coloured according to the values in a data file. The data file will usually be a DBF (dbase) file but it may also be a comma separated variable (or data) file (CSV or CSD) which can be written in a text editor or generated by most spreadsheets and databases.
- *Data points from external data.* Similarly an external data file may be used to control the values displayed by "data points". You are invited to choose from the styles in the current style set which have a data point selected as the point type for that style.

(Note: for the last three options, see the section below on Data linking).

6.c. Adding a scanned image as a layer

Map Maker assumes that a scanned image has north at the top. If this is not the case, image processing software should be used to rotate the image accordingly. When a scanned map is first used in *Map Maker* it must be calibrated using the "Calibrate scan" tool

By default a monochrome scanned image will appear as black lines on a white background. However, in many cases this can prove to be an overpowering background to other graphics. You can choose a different foreground colour than black for the scan by opening the **File** menu, clicking on **Display styles**, and clicking on **Set scan colour**. You will then be invited to click on a colour in a dialog box. Map maker will remember this colour and use it in future when loading scans. To change the colour of a scan that has already been loaded go to **File-Layer manager** and click on **Layer set-up**.

When a scanned map is chosen as the base layer, *Map Maker* will position the image so that its centre is in the centre of the screen. It will also choose a scale so that one pixel (dot) on the original scan is equivalent to one pixel on screen. This scale will give the clearest image. The map may still be zoomed, both in and out, but the quality of the image will be less than when at its "natural" resolution. If you zoom in, the image will become cruder with jagged lines, while if you zoom out detail will be lost.

Once a scanned image has been loaded it provides a useful back drop against which drawing files can be created using the drawing tools. When enough objects have been drawn the scanned image can often be dispensed with.

In the **Utilities - Scan utilities** menu there are a number of functions which can be useful when preparing scanned images:

- ***Get scan data.*** Displays an information panel about the selected scan file giving its size, calibration data, and resolution.
- ***Reverse image tones.*** Different scanning systems use different conventions for how to record black and white. Sometimes white appears as black and *vice versa*. This utility can reverse the tones in a file.

- ***Shrink TIFF file.*** Since scanned images take up so much room it can be useful to shrink a TIFF file and have it at a smaller scale. Some image processing software is quite crude in the way it shrinks files. This utility, while relatively slow, produces better results than many.
- ***Calibrate scan file***. While normally you will calibrate a scan using the "calibrate scan" tool there are occasions when it can be useful to calibrate an image numerically by defining the edges of the file.

6.d. Map assemblies

A finished map can consist of many elements including graphics layers, data files, margin settings, map furniture, a scale, an extent, and display styles. For maps which are going to be used again in the future all these components can be stored together as a map assembly in a .MAP file. When you load a MAP file all the components will be loaded and displayed as they where when saved. The MAP file does not contain copies of the data and graphics, it simply contains the names of these files. The user needs to be careful not to delete any of the components which a map file will use.

If you wish to copy a complete map to another machine use the **Utilities - Export file - Map file with components** menu item to ensure that all the necessary components are transferred.

7. The live layer

Sitting on top of all the layers is the so-called "live layer". This is a temporary layer in which objects can be created and edited using the appropriate tools. Unlike normal layers there can only ever be one live layer. The live layer can be saved to a file by clicking on **File - Live layer - Save as**.

7.a. Adding objects to the live layer

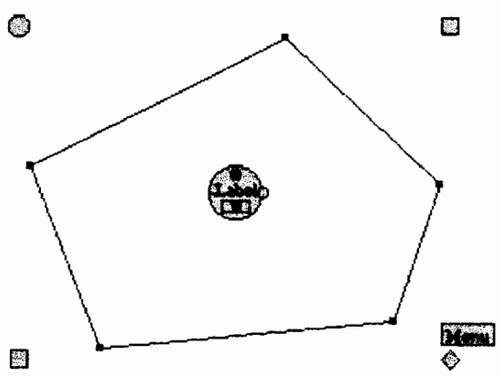
There are three ways of adding an object to the live layer:

- ***Drawing.*** Using the drawing tools new objects can be drawn directly into the live layer. To select a drawing tool click on **Tools - Drawing** and select a tool.
- ***Loading a file.*** All the objects in an existing DRA or LOC file may be loaded into the live layer by selecting **File - Live layer - Load file**. The objects can be edited, deleted or added to. The objects can then be saved back to the original file name or else saved to a new file.
- ***Hitting an object.*** If a layer has been set to be "hittable" then when an object is hit using the "data query" tool the user can click on a button in the dialog box which appears which adds the object to the live layer. In this way objects may be selected from several layers or else a small group selected from one file to create a new file. To select a group of adjacent objects use the "data query" tool and click and hold down the *right* mouse button. As you move the mouse you will draw a rectangle. When you release the right button Map Maker selects all the hittable objects in the rectangle and adds them to the live layer.

Note that an object in the live layer can always be distinguished from ones which are in the background layers by the presence of a small light blue circle.

7.b. Editing objects

Once in the live layer, objects can be edited, both in terms of their geometrical shape and the settings attached to the object such as display label, ID, and default display style. To do this choose the "edit object" tool. To edit an object's settings click once on the object. To edit the graphics double click on the object. When the geometry is being edited the object changes appearance. All vertices of lines and polygons appear as red squares and lines and polygons are enclosed by a groups of light blue symbols:



- ***Square in the top right***. By clicking and holding the left mouse button down over this square you can stretch the object both horizontally and vertically with the opposite corner, the bottom left, remaining stationary.
- ***Square in the bottom left.*** Similarly the object can be stretched with the top right corner remaining stationary by clicking on this square.
- ***Circle in the top left.*** By clicking on this circle and holding the mouse button down you can rotate the object.
- ***Diamond in the bottom right.*** The whole object can be moved without distortion by dragging this diamond. With polygons the same effect can also be achieved by clicking anywhere inside the polygon.
- ***The Menu box.*** In addition to these four symbols, there is also a blue box labelled "Menu". By clicking on this box a menu appears which allows you to alter some characteristics of the shape, or else to undo the last change.
- ***The label circle***. Polygons, lines and symbols, when being edited, all display a circle with the word "Label". The centre of this circle indicates where the object's label will be drawn. The mouse can be used to move this circle around. If the mouse is clicked on the edge of the circle the orientation of the label can be changed by rotating a guide line. Beneath the word "Label" there is a small box containing a red square. The mouse can be used to position the square to the left, centre or right of the box. The location of the red square determines whether the display label will be centred or left or right justified. Finally, by clicking on the small red spot above the word "Label" a dialog box will appear asking for a percentage size for the text. If the default of 100% is chosen then the label will be displayed at the size specified in the display style, otherwise it will be displayed as a percentage of this size.

By clicking on any of the vertices, shown as red squares, and holding the button down the vertex may be moved. If you press the "delete" key while moving a vertex then the vertex will be deleted. On any other occasion while in edit mode pressing the "delete" key will cause the whole object to be deleted. If you click on a line where there is no vertex a new vertex will be created.

If you are editing a line and you select a vertex, other than at the two ends, and while holding the mouse button down press the C key on the keyboard the line will be cut in two. Similarly, doing the same operation with a polygon will turn a filled polygon into a line where the two ends coincide.

If you select one of the two ends of a line and move the vertex so that it is touching another line in the live layer then while holding the mouse button down press the U or J key on the keyboard then one of two things happens:

- If the point of contact coincides with one of the ends of the second line then the two lines will be joined together.
- If the point of contact is elsewhere on the second line then the co-ordinates of the end vertex of the first line will be adjusted to coincide precisely with the point of contact. Thus, irrespective of how much the image may be zoomed in the junction will appear precise.

If the same procedure is done but the end vertex is placed over the other end of the same line then the line is transformed into a polygon.

If while editing the geometry of an object you press the "Ins" key a copy of the object will be made at the current position of the object.

By using the editing tools the accuracy of the map can be slowly upgraded as new data becomes available. You can start sketch maps simply by creating a few polygons, or even one, and then using the "cutter" tool, subdivide polygons and lines. With the cutter tool draw a line, with as

many vertices as you like, that crosses over the polygons and lines that you wish to cut. The cutting line must start and finish outside of the polygon rather than on its edge. Finish the cutting line by clicking with the right mouse button or pressing any key. The object will then be subdivided along the line drawn. Alternatively, using the "edit object" tool an existing line object may be selected by double-clicking and then the "menu" box clicked on and the **Cut** item selected. This allows you to make a cut and retain the cutting line.

The "join objects" tool can be used to unite two adjacent polygons. Click on one polygon then click again on the adjacent polygon and the second polygon will be merged with the first. If the second polygon is completely contained within the first polygon the second polygon is subtracted from the first to become a hole.

7.c. Using the fast menu

When drawing and editing in the live layer you will often be switching rapidly between one tool and another. To make this process less tedious there is a "Fast menu" which can be activated by clicking with the *right* mouse button. The menu appears on the screen at the point where you click. The menu contains the tools and procedures which you will most probably be using when working with the live layer.

7.d. Node and link drawing

Beginners to *Map Maker* will probably be most comfortable creating drawings from simple objects such as polygons, lines, and symbols and for many purposes this will prove to be perfectly adequate. However, there are many situations which call for the creation of either a cellular map or a network. A cellular map is made of adjacent non-overlapping polygons. A typical example might be a country divided up into provinces. If you try to draw such a map using the polygon drawing tool to draw each polygon it is very likely that the adjacent polygons will not precisely touch - there will be gaps and overlaps. Similarly a network, such as a road network, if drawn with the line drawing tool is likely to have messy junctions which do not meet precisely.

For these situations there is a second set of drawing tools for drawing nodes and links. A "node" is defined as a point where two or more lines meet or where a single line ends. A "link" is a line that links two nodes.

To create a network select the "Node tool" from the **Tools** menu and then click on the screen where you want a node. A node has no parameters associated with it so no dialog box appears. After a number of nodes have been drawn you can start using the "Link" tool. The link tool works like the Line drawing tool but if you click just anywhere nothing happens. To start a link you must click over a node, after this you can click anywhere to add more vertices to the link. To finish a link click over another node. An alternative to the link tool is the "Link pencil" tool which allows you to draw a free-form line by keeping the mouse button depressed. To finish a link drawn with the link pencil simply release the mouse button over the second node. If you release the button while not over a node the new link is deleted.

Using these tools you can rapidly draw a network of nodes and links. Using the links enclosed spaces - cells - can be created. To turn these into polygon objects which can be filled and edited like other polygons use the "flood-fill polygon" tool. With this tool click anywhere in the cell and Map Maker will seek out the enclosing links and create the polygon which is defined by the links. When this process is repeated in adjacent cells the result is polygons which touch precisely.

Often, once a cellular map has been created the nodes and links can be dispensed with since only the polygons are actually needed. To do this go to **File - Live layer - Transform** and select **Remove nodes and links**. Alternatively activate the "Fast menu" (see above) by clicking with the

right mouse button and choose **Remove nodes and links**. Either procedure will clear all the nodes and links leaving only the polygons.

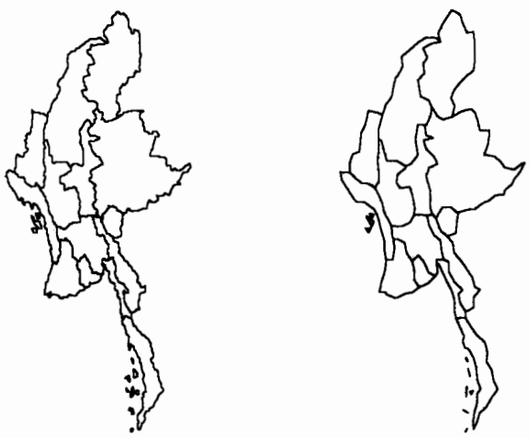
If polygons have been created in this way, for the purpose of editing they can be converted back to their constituent nodes and links. To do this activate the "Fast menu" (see above) and click on **Polygons -> nodes and links**. The nodes and links can then be moved and altered and then converted back to the polygons by going to the fast menu and clicking on **Nodes and links -> Polygons**. The polygons will then reappear complete with any information about their parameters (label and style) but with their boundaries altered according to the changes in the nodes and links. Using this procedure ensures that if you alter the boundary between two polygonal cells then the mutual boundary will remain precise.

The **Polygons -> nodes/links** facility may also be usefully employed if you have a drawing made up of lines with ends that coincide accurately. This is often the case if you have imported a drawing from another program, such as *ArcInfo*, for instance. By using Polygons -> nodes/links Map Maker will place nodes on the end of lines and if two or more nodes are found to occupy the same spot then just one node will be used for all the links ending at that point. These nodes and links can then be more readily converted into polygons, where applicable.

7.e. Transforming the live layer

The live layer sub-menu has a item called **Transform**. This gives access to a number of utilities for modifying the whole live layer:

- ***Shift, stretch, and rotate.*** The co-ordinates of the live layer objects can all be transformed through shifting up and down, or left and right, or else through rotation or stretching differentially in the X and Y directions.
- ***Simplify objects.*** Often a map is more detailed than it needs to be. For instance, if all you want is a little thumbnail map in a report a map used for detailed planning may be too complex and take up an undue amount of memory and disk space when imported into a document. Using this function the number of corners in a line, polygon, or link will be reduced by approximately 50%. This procedure may be called repeatedly to reduce the size still further.



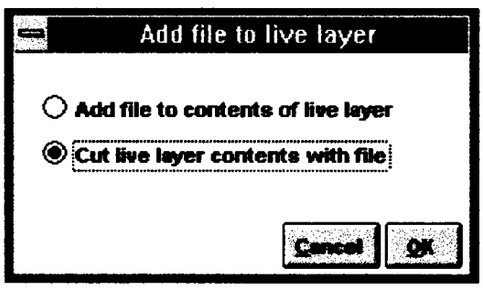
These two maps were derived from the same base file. The left hand map is in the original form and ocupies 38500 bytes of memory, the right hand map is a simplified version requiring only 6800 bytes, less than 18% of the original.

- ***Points from polygons.*** If the live layer contains polygons these can all be transformed into point symbols located at the point where each polygon's label is located. This can be useful if you wish to create a layer of symbols relating to a layer of polygons below.

- ***Lines from polygons***. Sometimes you may wish to have polygons turned into lines to just represent the boundaries rather than the solid objects. This utility will convert all the polygons found in the live layer.
- ***Generate polygons from seeds.*** If you have a live layer of points these can be used as "seeds" for growing polygons as if they were cells or soap bubbles. You are asked for a maximum bubble radius and then *Map Maker* will create polygons which are centred on the points and which are trimmed by the area of influence of adjoining polygons. This can be a very quick way of creating approximate maps from simple point data.
- ***Set all objects to one style***. If the objects in the live layer have been edited or if the live layer is made up of selections of objects from various sources then the objects in the live layer may have a variety of display style numbers (see section on display styles). Using this utility all the objects in the live layer may be set to one display style number between zero and one hundred.
- ***Find total area of polygons***. If a file has been loaded into the live layer which consists of polygons, for instance polygons describing a group of farms, it can be useful to get the total area of the polygons. This utility will return this total area.
- ***Remove nodes and links***. If, as described above, nodes and links are just being used as an intermediate stage in drawing a cellular map, this utility can be used to remove the nodes and links just leaving the polygons.
- ***Remove selected object types***. Particularly in files which have been imported from elsewhere there may be data which is not required for your purposes. For instance, it may be that you only require polygons and lines and do not require point symbols and text. Using this utility you can choose which object types should be removed.

7.f. Cutting the live layer with a file

If you have objects in the live layer they can be cut into smaller objects by overlaying another file. For instance if you have a file containing polygons representing urban districts and you had another file containing areas of different population density you could create a new file that showed the intersections of these different sets of polygons. To do this, load the first file - the districts - into the live layer using **File - Live layer - Load file**. Then do the same with the file containing the population density polygons. This time, because something is already in the live layer, the dialog box shown below will appear.



If you select "Cut live layer contents with file" and click on OK then the live layer will be cut by the polygons and lines in the file.

8. Obtaining map data

Map data can come from a variety of sources. Where data is copied from elsewhere it is the users responsibility to ensure that any issues of copyright are dealt with correctly. The sources can be summarised as:

- Scanning images
- Commercial (and public domain) data sets
- Graphical files produced by other programs
- Digitising tablets
- Field survey data
- On-screen copying

8.a. Scanning images

There are numerous scanners on the market and also numerous good image processing packages for manipulating scanned images, such as *PhotoFinish, PhotoShop* etc. For this reason Map Maker does not have its own interface for directly supporting scanners but it can make use of scans. Scans are useful for getting a rapid base map from which other layers can be drawn. There are many scanned images which can be obtained over the Internet though many are of disappointing quality.

8.b. Commercial and public domain data sets

There are various vendors of geographical data sets, such as the Ordnance Survey in the UK and USGS in the USA. There are also some public domain data sets such as that provided by WHO with their EpiMap software. Map Maker can read some of these data sets through the **Import file** utility in the **Utilities** menu (Note: a wider range of import formats is available in a separate program - *Map Maker Tools* - which is available as shareware from the World Wide Web site). These data sets are generally in a format designed not for immediate use in a mapping program but rather for the exchange of data thus programs like Map Maker need to carry out an import procedure to convert them to the internal format used by the program (in Map Maker's case the DRA format).

8.c. Graphical files produced by other programs

There are many GIS (Geographical Information Systems) packages in operation around the world. Rather than re-entering all the data from scratch it is often useful to be able to transfer existing data from one program to another. The commonest programs used in development projects for GIS are *ArcInfo, Atlas GIS, MapInfo, IDRISI*, and *AutoCAD*. The last, *AutoCAD*, is not really a GIS package but is the most common computer aided design (CAD) package and so there are many people familiar with it. All these packages are capable of exporting files in the DXF format (Data eXchange Format developed by *AutoCAD*). In addition most of these programs have other formats through which to export data. Map Maker can read DXF files through the **Utilities-Import file** procedure and convert them to DRA files and can also convert a number of other formats.

ArcInfo

To import vector graphic data from ArcInfo you should use the ArcInfo EXPORT command using the options for uncompressed text format. Alternatively you can use the UNGEN format which has the advantage of being produced by some other programs as well.

IDRISI

To import vector graphic data from IDRISI you should export the file from IDRISI in DXF format. To import bitmap images you should export as a BMP file.

8.d. Digitising tablets

One of the commonest ways of creating a digital map is to use a digitising tablet (or digitiser), which is like a drawing board linked to a computer. Since there is (remarkably) no standard Windows interface format for digitizers *Map Maker* does not have direct support for digitizers. Most users with digitizers will already have CAD software for digitising, such as *AutoCAD*, *FastCAD*, or *TurboCAD* so the approach taken here is that users with digitisers should do the digitisation through their CAD package and then export it to *Map Maker* as a DXF file.

8.e. Field survey data

Map Maker can convert numerical data collected in the field and convert it directly into a map layer. Also from *Map Maker* you can create surveying instruments to assist with making the survey. Survey data can be entered by creating a text file written in a special easy to learn format known as the XY format (see below for section on field surveys). An XY file may be written in any text editor and imported using the **Import file** utility.

8.f. On-screen copying

The above techniques are all capable of producing very accurate maps. In many cases such accuracy is redundant. One of the oldest ways (used by the ancient Egyptians and Greeks) of transferring a drawing from one sheet to another surface is to draw a grid over the original, draw a corresponding grid on the surface, maybe to a larger scale, and then use one's judgement to draw the lines of the drawing on the second surface using the grid as a guide so ensuring that even if the copy is not 100% accurate it, at least, will never be far wrong. The finer the grid used the greater the accuracy which may be achieved.

In *Map Maker*, under the **View** menu one can choose to show a grid of a specified spacing on the screen. Use the zoom-in and zoom-out buttons to get approximately the desired extent on screen. You can then draw a grid on your paper map or, if preferred, you can go to the **Utilities - Print survey tool -Scale grid** to print out a grid. If you put a sheet of tracing paper in your printer you will have a grid which you can lay over your original.

9. Objects

A drawing file (DRA) and also location and XY files (LOC and XY) are made up of objects. The objects available are polygons, lines, symbols (points), text, arrows, nodes, and links.

9.a. Parameters

Each object (excluding a node or a link) has a certain amount of basic information attached to it:

- ***A unique identification name (ID).*** The unique name (or ID) becomes important if you wish to attach data from a data file to the object. The unique ID must be the same for both the object and the entry in the data file. If there are two objects with the same ID the wrong data may be attached to the object. There is a limit of 254 characters for the ID.
- ***A display label.*** While the ID must be unique in many cases there are objects on a map which share the same name displayed on the finished map. For instance, you may have several objects labelled "bridge" on the map. These bridges may have unique IDs such as bridge 1, bridge 2 etc. but the label which they are displayed with is simply "bridge". The display label may also be a block of text with up to 65,000 characters.
- ***A default style number.*** Each object in a DRA file has a default style number between zero and a hundred. This number determines how the object is displayed unless the user specifically instructs that the display is altered according to data values.

9.b. Symbols

There are four different types of symbol available: simple symbols, single data value symbols, multiple data value symbols, and user-defined custom symbols. The single and multiple data value symbols change their appearance depending on the values of data items associated with them. For instance, there are pie charts and histograms which display values. There are also simple spots and triangles whose size varies in accordance with a data value (see section on data linking).

To make a symbol have a given appearance you must define a display style to have the desired symbol and then assign that display style to the object with the appropriate style number (see section on display styles).

9.c. Lines

Line objects can have any numbers of vertices linked by straight lines. By using the display styles the appearance of the line can be altered. It can be a solid line, dotted, dashed, a double line, or made up of symbols of user-definable size and spacing. Unfortunately, in *Windows,* dotted and dashed lines can only be drawn at one thickness but other line types can be drawn at widths defined by the user.

9.d. Polygons

Polygons have borders drawn using the same line styles as are available for lines. In addition, the style in which the polygon is filled can be controlled. The fill can be a solid colour or hatched. The fill may be opaque or translucent allowing layers underneath to be seen through the fill. Polygons may be complex polygons with holes cut out of them or have satellite islands forming part of a single polygon object (see the Join objects tool).

9.e. Text objects

A text object has to be distinguished from something like a text panel which is not related to a specific geographical location. A text object might be something like the name of a road, river or mountain range. It is attached to a particular piece of geography and its size is dependent on the

degree to which the map is zoomed in or out. Because of this, the height of the text is given as a distance on the ground. The style of the text is the same as that selected for labels in the current display style. Text objects may be written at an angle and justified in a variety of ways:

- Left justified
- Right justified
- Centre justified
- Stretched between two points
- Curved, following a circular arc
- Sinuous curve, following an "S" curve

9.f. Arrows

An arrow object, like a text object, relates a piece of text to a geographical point. Unlike the text object, the text remains the same height irrespective of the degree of zoom. The text is related to the geographic point by a line. The line may be terminated by an arrow head, a solid circle, or an open circle. The text can, if desired, be placed in a box. The style of the arrow is determined by the display style.

9.g. Nodes

A node is used exclusively for the purpose of marking the end on a link or an intersection of links. It appears on the screen as a yellow dot when in the live layer but it does not print out. It is used exclusively with links.

9.h. Links

A link is a line which starts and ends with a node. Its geometry can be edited like that of a line but it has no label or style.

10. Display styles

An polygon, line, symbol, arrow or text object from a DRA file has a number attached to it between zero and one hundred. This number is its style number. The style number attached to an object may be the one contained in the DRA file or else be read from a separate data file. Wherever the number comes from the end result is simply a number in the range 0-100. This style number is then used as an index to look up the definition of a style in a style file (.STL).

Each style file contains 101 styles for the range 0-100. Each of the 101 styles contains the definition for displaying:

- A symbol
- A line
- A polygon fill
- A text label
- An arrow

The style definitions are used to determine how to display any object with the given style number.

Any quantity of new style files may be created by the user and each style file may be edited. Within the file each of the 101 styles has its own name. When a new style file is created there are default names for each style but you may define your own names for the styles. For instance, you may have a style file for agriculture in which there are styles with names such as "wheat" or "irrigated".

In a map which has several layers, each layer may have its own style file. Thus in one map there may be separate style files relating to different thematic areas such as agriculture, infrastructure, water etc. Where no special style file is defined for a layer a default style file is used. The default style file applies all the time to all maps and, like the other style files, may be edited by the user. Many users will only need the default style file since the 101 available styles will cover all their needs.

In parallel to defining styles you can create legend files (.LEG) and data band files (.DFF) which can be used with the "furniture maker" tool to make a legend or key on the map. The legend editor on the **File-Display styles** sub-menu allows you to compose new legend files and edit existing ones.

11. Custom symbols

You can define your own symbols. To do this clear the screen then use the drawing tools to draw, as large as you like, the shape which you wish your symbol to be. The final symbol will be drawn all in one colour and polygons are shown solid so do not try and mix colours and fill patterns. When you have completed the drawing of the symbol, go to **File - Live layer - Save as.**. and save the drawing as a DRA file. On installation Map Maker creates a sub-directory called SYMBOLS, you are advised to keep your DRA files which describe symbols in this directory.

Go to the **File - Display styles - Edit custom symbol set**. A dialog box appears, click on the button labelled "Add" and choose the DRA file which you have just drawn. The filename is added to the list and a preview of the symbol appears in the top right. Custom symbols may be stored in sets so that you can develop libraries of specialist symbols for different tasks.

It is unwise to have too many custom symbols in your default style set since this is likely to slow down operations.

When you are using custom symbols on your map you can rotate them to any angle. Use the "Edit object" tool, click on the symbol once, and the object parameters dialog box will, if a custom symbol is selected, have a box where the rotation in degrees can be specified. This feature is particularly useful for symbols such as bridges or directional arrows which need to be aligned in a certain direction.

12. Map furniture

Map furniture refers to all those items which appear on a map which are not geographically located. These are:

- ***Plain panel.*** The plain panel is simply a panel on which other items such as north points and scale bars can be grouped together if desired. The panel can have any colour and there are a variety of border styles.
- ***Simple title.*** On many maps the only furniture required is a simple title. Using the "simple title" panel one line of text can be entered and the text is automatically scaled to fit within the width of the panel.
- ***North point***. There are several types of north point to choose from. They are automatically scaled to fit in the size of box drawn. The north point can be rotated but as a general rule north should be kept pointing upwards since the coordinate system assumes this orientation.
- ***Scale bar.*** There are several types of scale bar available. The extent of the scale bar is adjusted to fit the box while the scale itself is automatically set and updated to always be correct to the map.
- ***Legend (or key).*** A legend (or key) can be displayed by selecting a previously prepared legend file (.LEG) or Data band file (.DFF). The legend will show what the different display styles represent.
- ***Bit map (BMP) file.*** An industry standard windows bit map (.BMP) file can be displayed in a panel. BMP files can come from a variety of sources such as scanners or image processing software. A BMP file may be of a photograph, for instance. The image is scaled to fit in the box.
- ***Text panel.*** A short ASCII text file can be displayed. The text file may be simple text or else it can include a number of control codes which can be simply added in a text editor. The codes are enclosed within square brackets such as [bold on]. More than one code can be used at once with the codes separated by a comma such as [bold on,italic off,height 4.0].

  The available codes are:

  `Bold on.`
  `Bold off.`
  `Italic on.`
  `Italic off.`
  `Height xxxxx.` Where "height" is followed by a height in millimetres.
  `Black.`
  `Red.`
  `Green.`
  `Blue.`
  `Font xxxxx.` Where "font" is followed by a font name
  `Spacing xxxxx` Where "spacing" is followed by a number indicting the line spacing as a proportion of font height, eg. 1.5 means one and a half spaced.

These codes may be placed anywhere in the text so that single words, letters, lines, etc. can be picked out in italics, colours, special fonts etc.

13. Tools

At any one moment there can only be one tool selected. The selected tool determines what you can do with the mouse. The tools can be selected from the **Tools** menu and many of them can also be selected from the keyboard using the "Control" key and a letter.

Zoom to box

By clicking the mouse and holding the left mouse button down and dragging you can draw a box in the shape of the current map window. When you release the mouse button *Map Maker* will alter the scale and centre the map so that the area defined by the box fills the window.

Pan by dragging

By clicking the mouse and holding the left mouse button down and then moving the cursor and finally releasing the button you can move (pan) the map. The point where the mouse was clicked is moved to the point where it was released.

Measurement - Tape measure.

By clicking the mouse repeatedly you can lay down a tape measure. As the mouse is moved the distance is shown in the bottom left of the screen. To clear the tape press any key.or click the right mouse button.

Measurement - Area measurer.

Similarly you can draw a polygon. When the mouse is clicked over the first spot, or the right mouse button is clicked, the polygon is closed and the area is shown.

Measurement - Angle measurer

If you click on a spot then move the mouse around the compass bearing from that spot will be shown in the bottom left of the screen. Click a second time to clear it.

Snap shot - to clipboard

As with "zoom to box" you can define a box on the screen. When you release the mouse the area enclosed by the box will be saved to the *Windows* clipboard. The contents of the clipboard can then be pasted into word processed documents etc. (see your *Windows* and word processor manuals for details of the clipboard).

Snap shot - to file

As with "zoom to box" you can define a box on the screen. When you release the mouse the area enclosed by the box will be saved to a graphics file. The contents of the file can then be pasted into word processed documents etc. (see your word processor manuals for details).

Drawing - Line.

By clicking with the mouse you can draw a line made up of straight line segments. To finish a line press any key on the keyboard or click the right mouse button. To delete the last point press the backspace key. To abort the line press "Escape".

Drawing - Polygon

The polygon tool works like the line tool except that you finish the polygon by clicking over the first point or else clicking the right mouse button.

Drawing - Pencil

The pencil tool allows you to draw free-hand. Click the mouse button and hold it down. As you move the mouse a line is drawn. When you release the button the line is finished. If you release the button over the starting point of the line then *Map Maker* forms a polygon instead of a line..

Drawing - Symbol (point)

Simply by clicking on a spot on the screen a symbol will be created.

Drawing - Text object

A text object is an item of text which is tied to a geographical feature both in terms of size and location. Typical examples are the name of a river or mountain range which runs the length of the feature. Unlike the label of a line, polygon, or point whose size is determined by the style, a text object has a height defined in terms of metres on the ground. A text object can be justified in a number of ways including steteched and curved formats.

Drawing - Arrows

There are several styles of arrow available which can be selected from the Display Styles editor and allocated to a given style. The arrows drawing tool requires the user to define two points. The first point is where the arrow points too, the second is the start of the text label.

Drawing - Circle

Click on where you want the centre of the circle, hold the mouse button down and drag the cursor. When the circle is the desired size release the mouse button. The shape created is actually a polygon rather than a true circle, so all the other tools for manipulating polygons are available.

Drawing - Node and link

A node is an intersection of two or more lines. A link is a line which connects two nodes. Use the node tool to draw the intersections where lines join then use the link tool to connect them

Drawing - Link pencil

A node is an intersection of two or more lines. A link is a line which connects two nodes. With the link pencil, if you click where there is no node nothing happens. If you click on a node then it starts drawing a link as you move the mouse with the button held down. If you release the button over another node the link is completed. If you release the button not over a node the link is aborted.

Drawing - Flood-fill polygon

Once a network of nodes and links has been created you can use this tool to create polygons simply by clicking in one of the cells of the network.

Drawing - Polygons from nodes

Once a set of nodes and links have been defined you can use this tool to click, in sequence, on a group of nodes that are at the corners of a polygon. To finish the polygon click again on the first

node. Map Maker will then find the links which connect the nodes and then merge them to create the polygon. This method of drawing polygons is useful for creating a set of adjoining polygons.

Edit - Edit object

With the "edit object" tool selected click once on an object in the live layer to edit its settings, double click to edit the geometry. For details of editing the geometry see the section above on the Live layer.

Edit - Cutter

With the "cutter" tool you can draw a line with one or more segments. When you complete the line by pressing a key, or clicking on the right mouse button, the line will cut any polygon in the live layer which it crosses.

Edit - Join objects

The "join" tool can be used to join together two polygons. Click on one polygon then click on the other. If the two polygons are touching at two or more consecutive points then the two polygons will be welded together taking on the name and characteristics of the first polygon. If the second polygon is entirely contained within the first then the second polygon will become a polygonal hole in the first polygon. If the second polygon is completely detached from the first then it will become a satellite polygon.

Data query

The data query tool retrieves data about any object in the live layer and any object in any layer which has been defined to be "hittable". If no data has been attached to a hittable layer then the data query tool will return elementary data about the object such as its ID, display label, area (for polygons) and length (for lines). If there is data attached it will display the data values. Any numerical values for a polygon can also be seen in terms of units per square metre (or hectare or kilometre). Similarly data for lines can be seen in terms of units per linear metre or kilometre.

Surface query

The surface query tool is only available when at least one data surface has been loaded. The surface query tool returns the value of each of the current surfaces at the point where the mouse is clicked (see data surfaces in section on using data).

Furniture maker

The "furniture maker" tool allows you to draw boxes and then assign them to a particular furniture type (see section on Map furniture). Once a furniture box has been created the furniture maker tool can also be used to move it about the screen or change its shape.

Margin editor

When in "page preview" mode, the margin editor can be used to alter the page margins by grabbing them with the mouse and dragging them to new positions.

Calibrate scan

Before a scanned map can be usefully used you must calibrate it. To do this you need to know two things:

- The original scale of the paper map.

- The co-ordinates (X,Y) in metres of a known reference point on the map. If there is no known reference point then an arbitrary reference point should be selected and a co-ordinate defined. This can be 0,0 but it is often sensible to choose a larger value such as 10000,10000 to ensure that all co-ordinates on your map are positive to avoid any confusion that may result in having negative values.

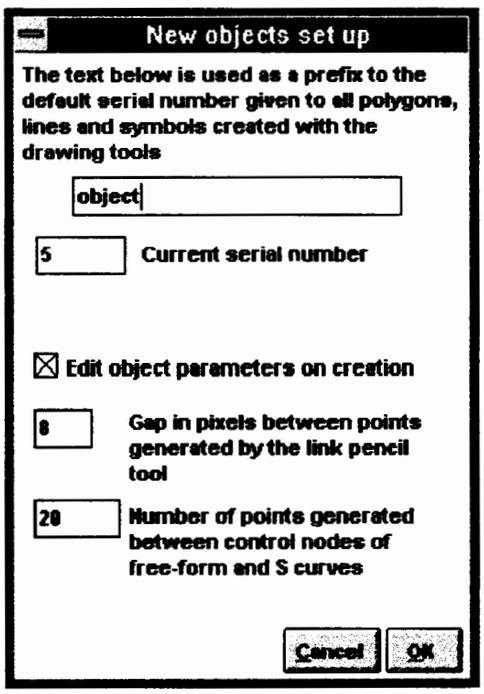
Use the navigation buttons on the bottom right of the screen to manoeuvre the map so that the desired reference point can be seen. Open the **Tools** menu and select **calibrate scan**, click on the reference point. In the dialog box that appears enter the co-ordinates of the reference point and the scale on paper. Click on the "OK" button and the map is now calibrated and ready for use. (Note that your scanned TIFF or BMP file is altered by this process so it must not be on a read-only disk such as a read only CD).

Snap to

When using the drawing tools, such as polygon, line, or symbol (point), the points drawn will be placed at the nearest pixel on the screen when the mouse is clicked if "Snap to" is set to "None". However if "Snap to" is set to "Full grid" then the point will be placed at the closest grid line intersection using the currently selected grid. (Note: to activate a grid go to the **View** menu). Alternatively a fraction of a grid square can be selected..

New object set-up

Clicking on **Tools - Drawing - New object set-up** produces a dialog box which allows you to determine some aspects of what happens when an object is first created:



- ***Prefix***. When an object is created it is given a default name. The default name consists of a serial number preceded by a text item. This prefix can be blank or set to a word like "Object". If you are drawing a number of similar objects you can set a prefix of your own like "Forestry plot" or some such thing.

- ***Current serial number***. The serial number is automatically incremented, starting from one, but you can also manually set the start serial number, so if you wanted to draw "Forestry plot 201" to "Forestry plot 220" you could set the current serial number to 201 and start drawing.
- ***Edit parameters on creation.*** If this box is checked it means that when a new object is first drawn a dialog box appears inviting you to set the display style, the object label, and the object ID. In many cases this is not necessary so by turning off this check-box you can prevent the dialog box from appearing.
- ***Gaps in pencil line***. When using the pencil or link pencil tool Map Maker actually draws a series of straight line segments approximating to the free-form curve drawn. The number placed here determines the approximate gap in pixels between vertices. The smaller the number the greater the number of vertices.
- ***Number of points between control points***. Lines and polygons can be drawn as "free-form" curves where the vertices of the line or polygon are control points for generating a mathematical curve. Similarly, text objects can be drawn along S curves. The number placed here determines how many points are generated along the curve between each control point.

14. Using data

14.a. Data points

Map Maker can display a range of symbol types, including user-defined symbols. Included in this range are a number of symbols which can be used to indicate the value of a variable. These are:

- A single value pie-chart
- A bar of fixed height which is coloured for a proportion of its length
- A solid spot the diameter of which is governed by the variable
- A triangle the height of which is governed by the variable.
- A circle with a percentage number written inside
- A "shop label" with a percentage number inside

To use any of these you must use the **File - Display styles - Edit style set** menu item. Select a style, then click on the button marked "Edit symbol and label". From the scrolling list of symbols select the data point symbol that you want and click OK. That data point type is now associated with that style.

When loading a layer, at layer set-up choose the "Data points from external data" option. You will be asked to select your data file and then to choose which column in the data file should be used to govern the appearance of each point. The values in the column should be in the range 0-100. After clicking OK, a list will appear showing which of the styles in the current style set has a data point associated with it. Choose the style you want to use and click OK, the layer will then be displayed with data points set to the value for each object.

Apart from the six single-value data points there are also four multiple-value data points:

- A percentage histogram, in which each column shows a percentage
- A unit histogram, in which each column is a stack of squares each representing one unit, this is useful for showing things like family composition
- A percentage pie-chart, in which the whole circle is assumed to be a 100% and each value in the database is taken as a percentage.
- A proportion pie chart in which all the values for a given object are added and the total is taken to be the full circle. The pie slices are then calculated as a fraction of this total. This allows numbers totalling more than 100 to be used.

The procedure for multiple-value data points is the same as for single-value data points except that all the columns in the data base are used. The user must therefore make sure that the data base is correctly set up.

14.b. Data linking

When a DRA file is loaded, or subsequently using the layer manager, you have the option of attaching a data file to the layer.

Data types

The data file can be in the form of a dBase (.DBF) file or a comma separated data file (CSV or CSD). The former can be produced by most data base programs while the latter is a simple text format which can be produced by most spreadsheets and databases as well as prepared manually using a word processor. A CSV or CSD file is an ASCII file in which the first line contains column headings

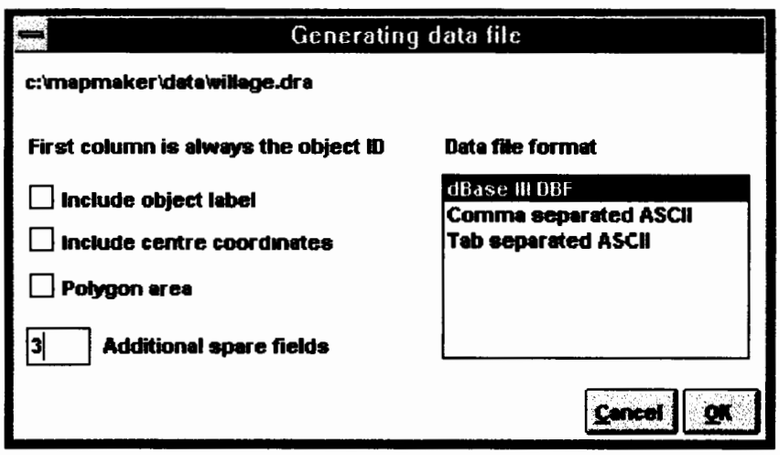
and each subsequent line starts with the unique ID of an object in a DRA or LOC file. Following the object there is one or more values separated by commas.

```
Label,staff,mortality,population
Gilgit Health centre,6,23.56,12354
Hunza hospital,13,18.40,45623
```

Note that the comma separated file chosen can be a LOC file (containing points only) which is simply a special case of a comma separated data file.

Generating a database

If you have an existing database then when you draw the map you must ensure that the "ID" of each cell corresponds with that in the database. However, often the map will be drawn first and then the database created. In this case, go to **File - Data - Generate data file**. You will be asked to name the drawing file from which you want to generate the database, in other words the layer for which you want a database. Select the file and then you will be presented with the following window:

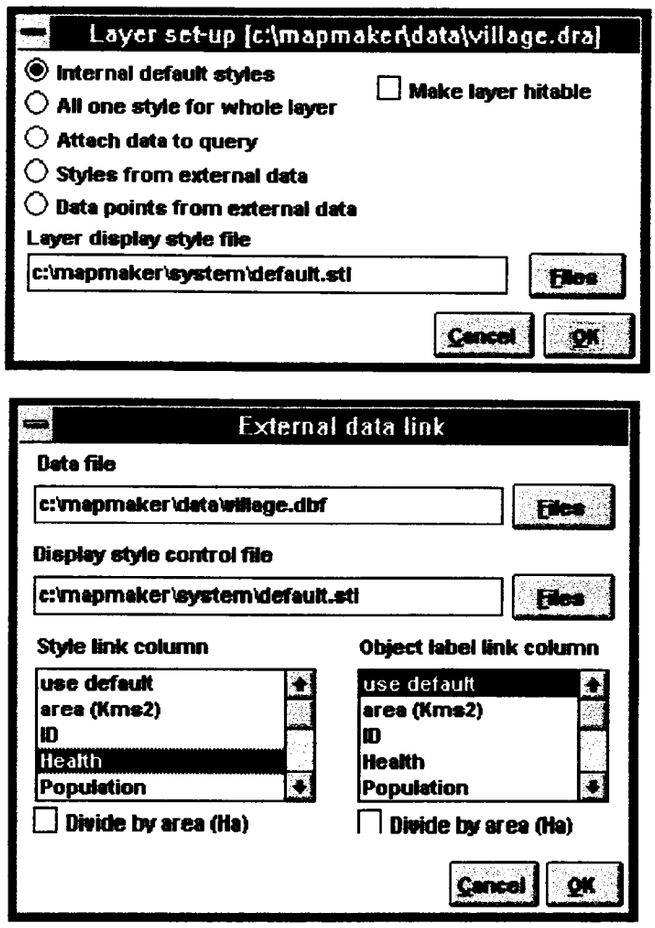


On the right hand side you can choose the file format, normally you would choose the DBF format since this is compatible with most databases. The first column of your database will always contain the "ID" of the objects in the drawing file since this is what makes the link between the data and the graphic object. You may choose to also include columns for the object label (which may or may not be the same as the ID), the centre co-ordinates of the polygon, or the area of the polygon, but normally you will simply ask for one or more "Additional spare fields", in other words empty columns into which you can put data later. Click on OK and you will be asked to name the file and the data base will be created.

Once created you can either edit the database within any database program (e.g. dBase, FoxPro, Access, etc.) or you can use Map Maker's own simple data editor by choosing **File - Data - Edit data file**.

Making the link

When adding a layer or opening a DRA file as the base layer you are presented with a dialog box for the "Layer set up". If you choose the "Styles from external data" option you will be asked to choose the data file and then you will be presented with a dialog box in which there are two lists each listing the names of the columns in the data file. In addition, at the beginning of each list there are the additional items "use default". and "area". By selecting an item from each of these lists you may determine both the display style of each object in the layer but also the label which will be displayed.

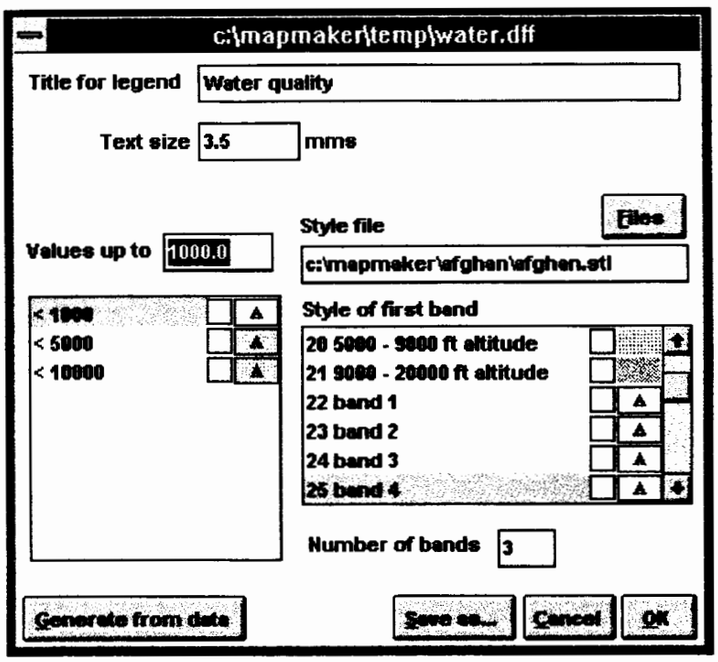


For instance, if you have a field called "health" and you select that as the "Style link column" then the objects in the layer will be coloured up according to the value in the health column. Similarly, if you also choose population as the "label link column" the population number will replace the default display label of the object when it is displayed.

In the same way, if when adding a layer you choose the "Data points from external data" option you can choose which data column should be used to govern the value in a single-value data point. If a multiple-value data point (pie-chart or histogram) is chosen all the columns (apart from the first containing the ID) are used so the user has to ensure that the columns contain sensible values for a pie-chart or histogram.

Data bands

Since a style number has to be in the range 0-100 many numbers in a database will need to be processed before they can be used as a style number. For instance, if a polygon has a population of 20,000 that number can not be used directly as a style number. In such cases it is necessary to use a Data Band File (.DFF) which is a file in which the user can define ranges of numbers which will be displayed using a given display style. To edit a data band files choose **File - Data - Edit data bands**. The dialog box which appears allows you to set how many bands you want, allocate the style of the first band (subsequent bands are automatically allocated the subsequent styles), define the top number for each band, and give a text label to the set of bands. This label will be used as a title to any legend (key) that is made using that data band file (see Map furniture).



Interrogating the data base

By attaching a data file to a graphic layer not only can you govern the way in which the layer is displayed you can also view and edit the data itself. If, after having loaded a layer, attached a data file, and defined the layer to be hittable, you select the "Data query" tool you will then be able to click the cursor on objects in that layer and the relevant data for that object will be displayed in a dialog box. This data can then be edited. If no data exists for the object you will be asked if you wish to add a data record. In this way a data base can be built up interactively with the graphics.

The data may also be edited in a tabular format by choosing **File - Data -Edit data** or else by using any of the major commercial database programs.

14.c. Data surfaces

Using irregularly distributed points *Map Maker* can generate three-dimensional surfaces. The surface can either be one which includes values associated with each point (e.g. altitude) or else it can portray the density of the distribution of points. The surface provides a "best guess" at values across the whole map area.

Generating a data surface

To enter point values use the Symbol (point) drawing tool to create the points and set the display caption of each point to the desired numerical value and then save the live layer to a file. If you are creating a surface to represent the density of points the display label is irrelevant.

Once the file of points is created, to generate the surface choose **File - Data -Data Surfaces** and select "Generate data surface" from the dialog box. You will be asked to name a surface file (SFC). After that a dialog box appears which requires three choices:

- The name of the surface. This does not refer to a DOS file name but rather to a meaningful name like "endemic species", or some such thing.

- The "grain" of the surface. The surface once created is a grid of squares with a value for each grid intersection. The grain refers to the coarseness of the grid. There are three ways of determining this:
  - A course grid for the current screen where *Map Maker* automatically chooses a starting point and a spacing for the grid based on geographic area covered by the current screen.
  - A fine grid also automatically determined.
  - A grid determined by a previously defined template. Using a template frees one from the shape of the screen and can be used to ensure consistency between different data sets.
- Whether the surface is one of point values or representing the density of points.

Once these choices have been made you are asked to select the data set which will be used to generate the surface. The data set is the DRA or LOC file which you have created with the points in it. *Map Maker* then generates the surface file.

Once the surface file has been created there are a number of things which can be done with it. The most simple task is to interrogate the surface.

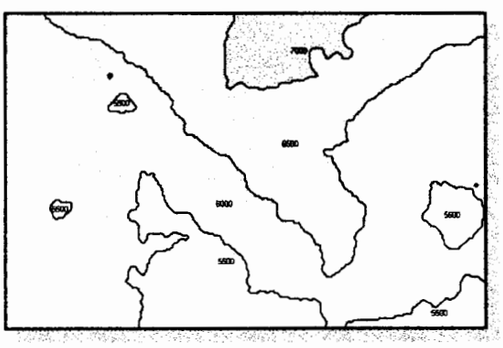
Interrogating surfaces

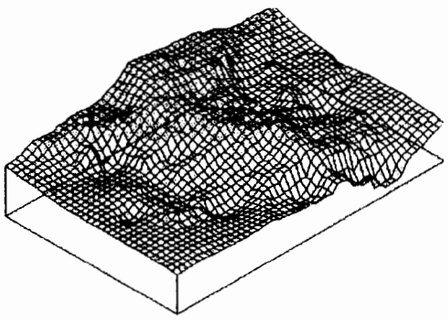
A surface, once generated, can be added to a map as a layer. When added it makes no difference to the appearance of the screen, it is an invisible data set associated with the map. Select **Tools - Surface query**. Now when you click on the map a box appears showing the value of the surface at that point. At any moment you can have several data surfaces loaded. If you do, the surface query will return a list of the values at that point for all the surfaces. In this way one variable may be compared against another.

View surface

Select **Data - Data Surfaces** and choose "View surface" and select the SFC file which you have generated. A three dimensional view of the surface will be displayed. Often the vertical values are small compared to the horizontal distances. If this is the case your surface will appear virtually flat. In such a case you should define a vertical magnification to increase the vertical values. Click on refresh. If the surface goes off the top of the screen you may need to set "Start value" to some number greater than zero, the surface will be lowered by this amount. If you click on the "With contours" check box, select a start value (i.e. a value as low as your lowest point value) and a sensible contour spacing then click on refresh. After a few seconds the contours will be drawn as coloured bands.

A data surface shown as contours and as a three dimensional view





Generate contours

Three forms of contour map can be produced from a data surface: a bitmap, vector lines, or vector polygons. The bitmap version can be useful if all you need is a simple background to other layers.

Whichever version you produce you need to define what resolution you want - the resolution being the number of samples per grid on the data surface. In the case of the bitmap the resolution determines the number of pixels per grid while with the vector contours the resolution effects the accuracy and smoothness of the lines generated. In the case of a complex surface if the resolution is too low the program may not be able to resolve the values into contours in which case a message appears suggesting that you try again with a finer resolution. Note that with a large data set generating contours can be a relatively slow process.

Merge surfaces

Many researchers are searching for interactions between different variables. Since a data surface is a graphic representation of a variable, two or more surfaces may be merged in different ways to come up with composite surfaces which represent some hypothesis about the way these surfaces interact. A different weighting may be given to each surface and then the surfaces may be added, subtracted, multiplied or divided or else the highest or lowest value may be taken depending on the needs of your model.

Polygon samples

While a data surface may be valuable for analysis, often at the end you will need a single value for an area, say a polygonal district in a region. A layer consisting of polygons - a cellular map - may be laid over a surface and *Map Maker* will produce a data base containing the average value of the surface across each polygon and also the lowest value, the highest value and the standard deviation (the spread) of values across the polygon.

15. Printing

Map Maker makes full use of the support for printers provided by *Windows 3.1*. That is to say any printer or plotter for which there is a fully compatible Windows 3.1 printer driver can be used by *Map Maker*. This allows for output on the cheapest of ink-jet or dot matrix printer as well as the most sophisticated of colour plotters. For details of how to install printer drivers consult your *Windows* manual.

15.a. Set-up

To change the printer or to change the paper size select the **File-Printer** menu item. To change margin sizes and border styles use the **File-Page set-up** menu item. To print simply select **File-Print** and specify the number of copies that you want to print. The way the image prints will also be governed by the choice of page view or screen view (see above for the section on the view).

15.b. Exporting images to word processors

As an alternative to direct printing you can export a map as a Windows Meta File. Windows Meta Files, which have a .WMF extension, are the industry standard format for exchanging data between *Windows* applications. A WMF graphics file can be imported into many other programmes such as the leading Windows word processors - *Word, Word perfect,* and *Lotus Ami Pro.* This allows you to prepare maps for inclusion in word processed reports. But be warned that a very large and complex map may exceed the memory limits imposed by the word processor. To export an image select **File-Export image**.

15.c. Poster print

When printing from screen view you have the option of producing a "poster print". A poster print is a map printed out on several sheets which can be stuck together with glue or tape after trimming off the margins. In this way a small conventional printer may be used to print a large wall map. The magnification available is in the range 2 - 10, requiring from 4 - 100 sheets of paper.

When doing a poster print you have the option of magnifying the line thicknesses and text height or not. Thus is you want a large map but still with fine lines then you can choose to turn off the option of magnifying lines.

16. Using latitude and longitude

Map Maker uses maps that are on an orthogonal grid. Often there is a need to relate grid co-ordinates to latitude and longitude values. There are many different types of map projection some of which are supported by *Map Maker*. To make use of latitude and longitude values you must create a map projection file (MPF) and subsequently select this file to determine how lat/long values are changed to XY co-ordinates and vice versa. To create and manipulate map projection files go to the **Utilities - Lat/long utilities** menu.

- ***Edit or create map projection.*** Allows you to simply define a relationship between a map projection and an XY co-ordinate system. In the dialog box, you must choose from a list of common map projection types, define the XY co-ordinate of a reference point near the centre of the area of interest and then specify the latitude and longitude of that same point.
- ***Convert lat/long to metres.*** A DRA file in which the co-ordinates are expressed as latitude and longitude positions (expressed as decimals) can be converted to co-ordinates in metres by selecting a previously defined map projection file.
- ***Convert metres to lat/long.*** A file with co-ordinates in metres can be converted to a file in which the co-ordinates are latitude and longitude co-ordinates by selecting a previously defined map projection file. Note that even if you have chosen to work in some other unit, like feet or yards, the DRA file will be in metres internally.
- ***Lat/long point to metres***. A latitude and longitude point can, with a previously defined map projection file, be converted to an XY co-ordinate. This can be useful for converting Geographical Positioning System (GPS) data to co-ordinates.

17. Field surveys

Map Maker is unusual in having support for surveys made in the field. You can not only process numerical survey data directly into maps but you can also use your printer to help make simple but respectably accurate surveying instruments.

17.a. The basics of surveying

Surveying is about locating points in relation to other known points.There are essentially only four basic ways of locating a new point with relation to other known points:

- ***Distance and direction.*** Measuring the distance and direction of the new point from a known point.
- ***Two distances.*** Measuring the distances from two known points.
- ***Two directions.*** Measuring the directions of the new point from two known points.
- ***Offset from a line.*** Measuring the perpendicular distance of the new point away from a point a known distance from one end of a straight line between two known points.

The procedures described below are simply developments around these four basic concepts.

17.b. Processing survey data

Map Maker can create drawings from an ASCII text file arranged in a simple format called the "XY" format. Similarly, *Map Maker* can export drawing files (.DRA) to the XY format. The XY format has been designed specifically for entering simple survey data. Also it can be used to convert a drawing into numbers which can be used to set out objects in the field. There are various ways of describing the corners of a surveyed object in an XY file:

- Simple XY co-ordinates (default)
- Distances from two reference points
- Compass bearings from two reference points
- Angles measured from two ends of a reference line
- Polar co-ordinates
- Relative polar co-ordinates
- Compass traverse in which each point is defined by a compass bearing from the previous point.
- Angle traverse where the angle of each line segment is measured from the previous line segment.
- Offsets from a line between two points

Distances and co-ordinates within an XY file can be described in various units:

- Metres (default)
- Yards
- Feet
- Chains (1 chain = 22 yards)

The simplest form of XY file is shown in the following example:

```
House plot 1, 123.45, 223.67
125.87, 245.90
145.00, 242.34
143.12, 221.32
123.45, 223.67
```

This short file would describe a single polygon called "House plot 1". Each number pair is a simple XY co-ordinate. Map Maker assumes that it is a polygon because the last co-ordinate is the same as the first.

If the file looked like:

```
BEARING,50.34,180.67,55.87,276.32
House plot 1, 67.44, 112.55
46.45, 98.09
54.33, 91.56
72.33, 113.20
67.55, 112.55
```

This would also describe one polygon but in terms of compass bearings from the two reference points described by the two co-ordinate pairs after the word "BEARING".

```
ANGLE,50.34,180.67,55.87,276.32
House plot 1, 67.44, 252.55
46.45, 228.09
54.33, 311.56
72.33, 323.20
67.55, 252.55
```

Here there are again two reference points defined after ther word "ANGLE". These two reference points define the two ends of a reference line. The points in the object are defined in terms of *clockwise* angles measured from the two reference points between the reference line and the corner being described.

```
POLAR,1134.33, 2322.88
House plot 1, 34.5, 23.45
12.22, 67.77
25.55, 75.44
34.65,58.56
34.5,23.45
```

When using POLAR co-ordinates only one reference point is required, which is defined by the number pair after the word "POLAR". The number pairs in subsequent objects are polar co-ordinates of an angle followed by a distance.

```
RELATIVE POLAR,1134.33, 2322.88,1176.42, 2398.08
House plot 1, 34.5, 23.45
12.22, 67.77
25.55, 75.44
34.65,58.56
34.5,23.45
```

In relative polar co-ordinates the angles are not measured from north but rather from a reference line defined by two XY points. The angles are measured from the first of the two points.

```
DISTANCE,50.34,180.67,55.87,276.32
House plot 1, 123.45, 223.67
125.87, 245.90
145.00, 242.34
143.12, 221.32
123.45, 223.67
```

Here the house plot is defined in terms of distances from two reference points. If the numbers are negative the point is to the left of the reference line as viewed from the first reference point, otherwise it is to the right.

```
COMPASS TRAVERSE
Forest path,0,0
23.45,123.56
67.78,234.22
176.4,12.3
65.20,450.56
```

In this example the first number pair of each object is an XY co-ordinate, subsequent number pairs are a compass bearing from the previous point to the next point and a distance.

```
ANGLE TRAVERSE
Boundary,0,0
0,25.54
230.33,12.65
154.66,5.54
278.32,24.23
```

In an angle traverse the first number pair is the XY co-ordinate of the start point, the second number pair contains the compass bearing of the first line segment followed by its length, in subsequent number pairs the first number is an angle of the direction of the next line segment measured from the previous line segment in a *clockwise* direction. The second number is the distance along the line.

With both angle traverses and compass traverses if the last point is meant to coincide with the first point then the last point should be followed by the word CLOSE which instructs *Map Maker* to detect the inevitable error between the first and last point and then spread the error proportionally between the other points in the polygons. For instance:

```
ANGLE TRAVERSE
Boundary,0,0
0,25.54
230.33,12.65
154.66,5.54
278.32,24.23
CLOSE
```

The final alternative is to describe an object in terms of an offset from a straight line between two reference points:

```
OFFSET,20.5,0.89,102.7,50.67
Rice field,23.2,2.12
25.3,1.87
27.1,2.8
39.8,3.6
```

In this form the first number of each pair in the object is a distance along the line and the second number is an offset measured at 90 degrees to the line.

In the forms which need reference points, you can change the values of the reference points, at any point, including in the middle of an object. In order to change either of the reference points include a line like:

```
REF 1, 23.45, 34.23
```

or

```
REF 2, 112.67, 76.88
```

Thus, you might have an XY file like:

```
DISTANCE,50.34,180.67,55.87,276.32
House plot 1, 123.45, 223.67
125.87, 245.90
145.00, 242.34
REF 1, 48.55, 234.56
143.12, 221.32
REF 1, 89.01, 195.55
123.45, 223.67
CLOSE
```

Where the first reference point is moved twice during the course of the survey. This may well happen where you cannot see all the corners of the object being surveyed from the first two reference points. Here also the word CLOSE is used to ensure that the polygon is closed and any errors absorbed.

Alternatively, you may define a series of reference points by name. There are two ways of doing this, firstly by explicit definition, e.g.

```
DEFINE,Point A1,50.34,180.67
```

Where "Point A1" is the unique name of a reference point with the co-ordinates specified. Subsequently, any command that calls for an XY co-ordinate can instead use the reference name, for instance the line:

```
DISTANCE,50.34,180.67,55.87,276.32
```

could be replaced by

```
DISTANCE,XY,Point A1,55.87,276.32
```

Where the word XY tells the program that the following term is a reference to an XY co-ordinate. The second way is to make a point in an object a reference point:

```
ANGLE TRAVERSE
Boundary,0,0
0,25.54
230.33,12.65 [G3]
154.66,5.54
278.32,24.23
CLOSE
```

In this example, the third point in the angle traverse becomes defined as the new reference point in square brackets, "G3". So even though we do not know its X and Y ordinates, *Map Maker* calculates the co-ordinates in the course of doing the angle traverse (in this case) and then assigns those co-ordinates to the new reference point.

By default *Map Maker* assumes that co-ordinates and distances are in metres, to define a different unit of measurement include a line at the beginning of the file with one of the following three words:

```
YARDS
```

```
FEET
CHAINS
```

If you need to switch back to metres you can include the word `METRES`.

17.c. Surveying tools

For centuries remarkably accurate surveys have been performed with what are essentially very low-technology instruments. The theodolite, which for the last couple of hundred years has been the mainstay of surveying, is - despite the beauty and precision of the engineering - based on the very simple concept of measuring an angle between two lines. The problem with such instruments has never been the complexity of the idea but rather the accuracy needed in their manufacture. Traditional surveying has always been dependent on the availability of skilled instrument makers.

These days computers and computer printers, despite the sophistication of their technology, are far more common than theodolites and other such instruments. *Map Maker* allows you to use your computer and printer as a manufacturing tool to help make relatively precise surveying instruments. Choose **Utilities - Print surveying tool** and select the instrument that you want.

Making a plane table

The "plane table" survey has historically been the most common form of survey. A horizontal wooden surface, like a table, is placed at a reference point and sightings made of the objects that are to be surveyed. This can either be done by drawing lines on a piece of paper radiating from a common point or else by measuring angles. Map Maker can help with making an easy-to-use plane table:

- Get a length of wood 280mms long with a rectangular section and good straight edges. The section should be approximately 15mms by 30mms.
- Decide which is the best straight edge of this wooden arm then knock a nail through the wood halfway along its length and 10mms in from its good straight edge. The nail should protrude through the other side of the wood by about 5mms,
- Click on the **Utilities - Print survey tool - Plane table** menu item from *Map Maker*. A dialog box will ask you the distance from the straight edge to the pivot. This should be 10mms but you should measure the actual distance from the edge to the centre of the nail as accurately as possible and enter the distance here. Click OK and the plane table base will print on two sheets of paper.
- One of the two sheets has a dashed line close to its left hand edge. carefully cut along this line then stick the two pieces of paper together to form the base.
- Cut out a piece of stiff plywood, or similar, 20mms larger in width and height than the sheet formed from the two pieces of paper.
- Stick the paper to the plywood with tape.
- Use a nail or some other sharp tool to form a hole at the centre then place the nail of the wooden arm in the hole. Angles can now be measured by viewing along the straight edge at the objects to be recorded.

When the plane table is placed on a firm base it is ready for use. Ideally it should be fixed to a tripod but if one is not available bases for the plane table can be improvised in the field, including a chair, a table, or the roof of a car. Where only a few angles need to be measured it will generally be easier to use the angle measurer described below.

Making an angle measurer

Map Maker's angle measurer is a simple hand-held tool for measuring horizontal angles. It is not suitable for measuring fine angles less than 30 degrees. To make the angle measurer:

- Get a length of wood 200mms long with a rectangular section and good straight edges. The section should be approximately 15mms by 30mms.
- Decide which is the best straight edge of this wooden arm then knock a nail through the wood 50mms from one end and 10mms in from its good straight edge. The nail should protrude through the other side of the wood by about 5mms.
- Get a small mirror 100mms long by about 25mms high. Stick the mirror to the straight edge of the wooden arm so that its centre coincides with the position of the nail.
- Click on the **Utilities - Print survey tools - Angle Measurer** menu item from *Map Maker*. A dialog box will ask you the distance from the mirror surface (the straight edge) to the pivot. This should be 10mms but you should measure the actual distance from the edge to the centre of the nail as accurately as possible and enter the distance here. Click OK and the angle measurer base will print out.
- Cut out a piece of stiff plywood, or similar, 20mms larger in width and height than the paper and stick the paper to it with sticky tape.
- The paper has two points marked **Sight**, one of which is the view point. At the one which is not the view point knock in a nail which protrudes above the paper by at least 30mms.
- Use a nail or some other sharp tool to form a hole at the centre of rotation (marked on the paper) then place the nail of the wooden arm in the hole. Angles between two objects can now be measured by viewing from the viewpoint and rotating the arm so that the reflection in the mirror of the object to be measured lines up with nail and the second object. Read the angle from the scale.

Where many angles have to be recorded from a fixed viewpoint it is preferable to use the plane table method.

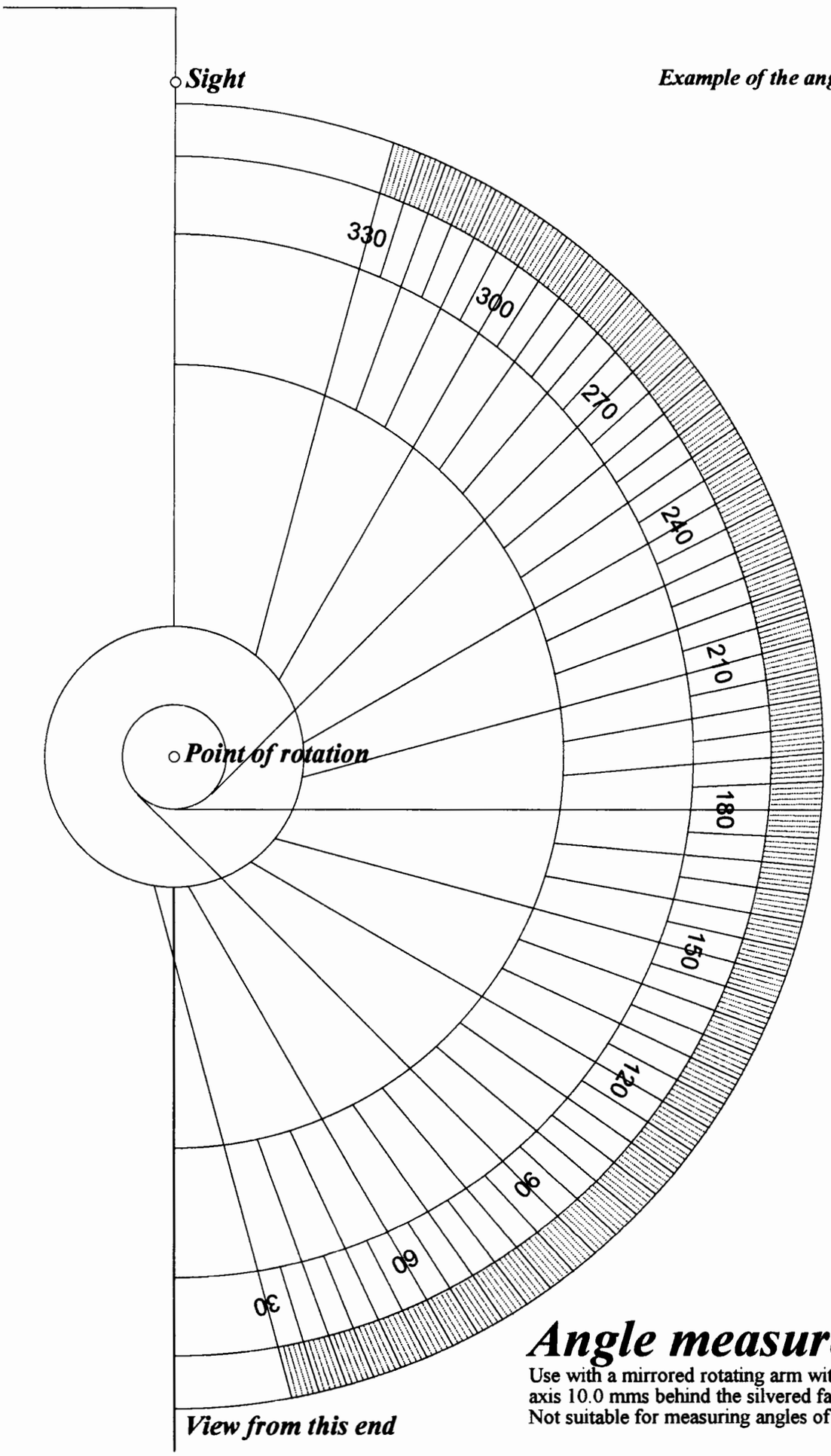
Making a clinometer

Map Maker is primarily concerned with locating objects in the horizontal plane. However, sometimes you may need to know heights. To make an instrument to measure vertical angles:

- Choose **Utilities - Print survey tool - Clinometer** and print.
- Stick the page down to a piece of plywood or similar.
- At the point indicated drill a hole through the paper and wood.
- Pass a thin thread through the hole with a weight an one side and secured on the other side.

To measure a vertical angle look along the site line and let the thread hang freely. You can measure the angle directly from a scale or else read off the tangent or sine of the angle directly from two other scales. If you need the height of vertical object and you can measure the horizontal distance from your observation point to the object (e.g. a water tower or a tree standing on a flat plane) then simply multiply the tangent of the angle by the distance. Alternatively if you are measuring the height of a hill and you can measure the distance along the slope multiply the sine of the angle by the distance along the slope. In both cases you need to remember to add the height of your eye level to the result.

To measure downward angles, such as down into a valley, simply turn the instrument around so that you look along the site line from the end of the site line with the hole.



Angle measurer

Use with a mirrored rotating arm with the hole for the axis 10.0 mms behind the silvered face of the mirror. Not suitable for measuring angles of less than 30 degr

Using photographs as survey tools

Photographs are, in effect, means of recording angles of objects from a viewpoint. With the appropriate tool you can measure angles directly from a photograph which can then be used as survey data. This can be particularly useful for surveying places which can only be visited briefly or infrequently.

To use photographs in this way it is necessary to calibrate your photographs. If you use a camera with changeable lenses, or a zoom lens, and you use prints of various sizes this can mean many calibrations. But for the many people who use simple fixed lens cameras and a photographic laboratory which produces prints of a fixed size, this will mean simply one process of calibration. To calibrate:

- Get a table and stand it parallel with a smooth plain wall so that the edge of the table furthest from the wall is 2 metres from the wall.
- Make a vertical pencil mark on the wall just above table height.
- Make two more vertical pencil marks either side of the first mark at the same height at exactly 352 mms from the first mark.
- Place your camera on the table opposite to and facing the first mark so that the *back* of the camera is 2 metres from the wall. Check by looking through the camera that the first mark is in the centre (horizontally) of the picture.
- Check that the two outer marks are in the picture. If they are not draw two more marks each 262.5mms from the centre mark. If these are still outside the picture, as may be the case with a telephoto lens, then draw two marks 174.5mms from the centre.
- Take a photograph of these marks and get it processed and printed in the normal way.

  On the print, measure the distance between the two outer marks in millimetres.
- Click on the **Utilities - Print survey tools - Photo scale** menu item. In the dialog box enter the distance in millimetres then in the box below enter:

  20 degrees if you used the marks at 352 mms
  15 degrees if you used the marks at 262.5 mms
  10 degrees if you used the marks at 174.5 mms
- Click on OK. *Map Maker* will now print out a scale in degrees from which you can measure angles either side of the centre of the photograph.

In the field you can take several photographs from one spot to get a panoramic view or you can just take one but always include a known spot, such as another reference point from which you are taking photographs so that the angles taken from the photograph can be related to other objects.

Making a solar compass

It is often useful to be able to find north. This can be difficult and even if you have a magnetic compass there can be the variation of magnetic north from true north and in addition there can be local variation caused by local geology and things such as power lines and buried water pipes. Also, many magnetic compasses are quite small and so hard to use accurately. As an alternative you can use *Map Maker* to produce a solar compass, which is like a sundial working backwards. To use this you need to know your approximate latitude and longitude and also your time zone relative to Greenwich Mean Time (GMT).

There are two versions of the compass one is easier to use than the other but it does not work well in the tropics (23.5 degrees north to 23.5 degrees south). To make the tropical version you need a piece of wood preferably between 50 and 100mms wide and about 300mms long. Both versions can

be produced either for one specific day or else for all year. The specific day version is easier to read while, clearly, the year long version is more versatile. In all cases the principle is to place the solar compass on a horizontal surface in the sun and then use a piece of wood placed vertically to cast a shadow. You use your watch which should be accurately set to local time and then revolve the solar compass until the shadow coincides with the markings which correspond to the correct time. When it coincides the compass is pointing to true north.

Distance estimator

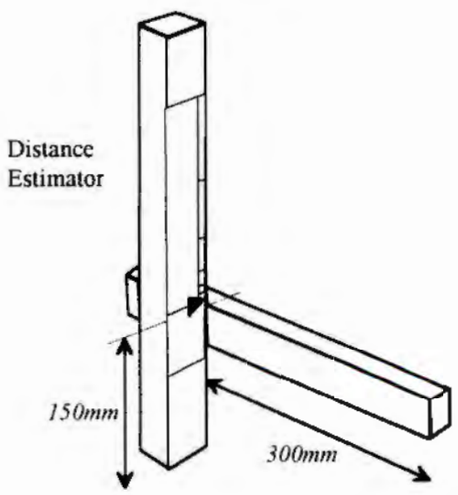
Measuring distance is often a simple process of using a tape measure or else pacing a distance, or maybe, in some circumstances, using the mileometer of a car. But sometimes it can be hard to do this because there is undergrowth, rivers, rocks or people in the way. In these situations, *Map Maker* can help with a distance estimator.

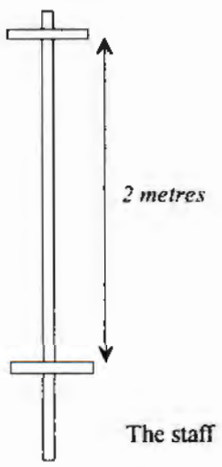
We all know that the further away that something is the smaller it appears. The extent of this effect is predictable with the use of the principles of perspective. For obtaining approximate distances *Map Maker* can print out a perspective scale. At its simplest the distance estimator is a length of wood about 450mm long by 30mm wide and 10mm deep. You hold the wood upright in your right hand with your arm outstretched at shoulder height and look towards it. An assistant then measures the distance from your eye to the wood. This distance is then entered into the computer and a scale is printed out which shows how high an object 1 metre high will appear to you against the piece of wood at specified distances. If the object you are viewing is actually three metres high (say a pole) then you simply multiply the distances by three.

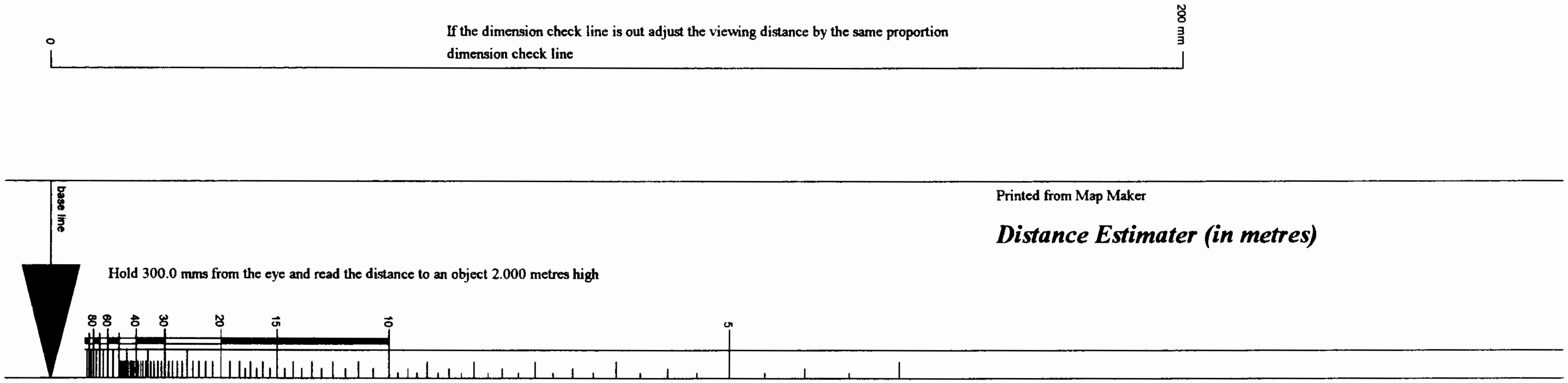
If desired, rather than using a one metre high object you can specify a height, which could, for instance, be the height of your assistant, say 1.65m high. Then as your assistant walks about the field you can tell how far away he or she is by looking at their height on the scale. Preferably a staff of a fixed height should be made such as that shown below.

A variation on this technique is to have a second piece of wood attached to the first at right angles. The end of the second piece is placed against your cheek below your eye so that its length determines how far away the first piece of wood is rather than the length of your arm. The advantage of doing this is that everybody can use the same scale. A good length is 300-400mm.

In trials, at ranges up to 150m, accuracy of within 4% was consistently achieved. This is not precision surveying but in many circumstances it is adequate.







Example of the distance estimator

18. Customising Map Maker

18.a. Customisation files

In Program Manager, if you select the *Map Maker* icon, go to the **File** menu and select **Copy** you can create a second copy on the *Map Maker* icon. If you now select this icon, go to the **File - Properties** you can change the name of the icon in the top line of the dialog box that appears. In the second line there is the "Command line" which includes the full name of the *Map Maker* program. If after the program name you enter a space and then the word "viewer" you will create a version of *Map Maker* which only allows the user to view and manipulate data. It does not include the more complex tools for graphic editing and other utilities. Typically the command line will now read:

```
c:\mapmaker\system\mm.exe viewer
```

Alternatively after the command line you can put the name of a simple text file which includes a set of commands which customises *Map Maker* to use it to display a certain set of data. It becomes an electronic atlas. e.g.:

```
c:\mapmaker\data\mm.exe custom.txt
```

The text file, in this case "`custom.txt`", should be in the same directory as the program, in this case "`c:\mapmaker\system`". A typical customization file would look like:

```
title,Volcanic hazards in the Azores
help file,Azores volcanic hazards,azores
map,Ancient eruption,c:\mapmaker\azores\furnas.map
map,1630 eruption,c:\mapmaker\azores\ash.map
map,Volcanic earthquake,c:\mapmaker\azores\mercalli.map
map,Pyroclastic bomb risk,c:\mapmaker\azores\bomb.map
copyright,Volcanology Research Foundation, 1995
start up,c:\mapmaker\azores\furnas.map
```

With this customisation file *Map Maker* will display a start up window containing the title and a copy right notice. After that *Map Maker* will have three menus, **File, Tools**, and **Help**. The tools menu contains a few basic tools for navigation and measurement. The Help file is that defined in the "Help" line of the customisation file, in this case `AZORES.HLP` which has to be located in the system directory. The **File** menu starts with the titles given to the maps listed in the customisation file. If you want a map to be automatically loaded at start up include the "Start up" line with the name of the map.

18.b. Hyper-maps

A hyper-map is a map in which you can click on an object with the Data Query tool and one of three things happens:

- The user will automatically be taken to a topic in a help file
- A different MAP file will be loaded.
- An external program will be run.

To make a hyper map you must have a data file attached to a hittable layer (see section on using data). If you want to change to a different map when you click on an object one of the fields in the data line corresponding to the object should include the full name of the new map file preceded by an

exclamation mark, e.g. `!c:\mapmaker\data\district.map` There should be no space between the exclamation mark and the name and no space before the exclamation mark.

Similarly to go to a topic in the current user help file you should have a field in the relevant line of the data base starting with a question mark and followed immediately by the name of a key word in the topic file, e.g. `?Social data`. Similarly, to run an external program you must put `!Run(program name)` in the data base.

Using the Windows help system you can also start programs from the text of the help file (using the ExecProgram help macro). When used with *Map Maker*'s custom help facility there is an additional help macro defined called "Map". If you pass the macro the name of a MAP file then it will automatically load that map. (See Windows programming manuals for more details of Help macros).

The user's custom help file can be loaded from the help menu and will be recorded in the map file when saved so ensuring that it is loaded automatically when the map file is loaded.

18.c. Creating help files

Map Maker can become a powerful education vehicle by the addition of custom-made hypertext making use of the *Windows* help system. You can create your own hypertext package by using *Microsoft Word* to create a document and saving it in the "Rich Text Format" (.RTF) and then compiling it as a help file within *Map Maker*. RTF files can be written from a number of word processors but *Word* seems to offer the most comprehensive support.

Within your RTF document you need to follow a few simple rules:

1 A help system is made up of a series of screens. Each screen can be thought of as a "card" in a card index system. Each card contains "links" to others cards.

2. Each card ends with a "Hard" page break inserted from the "Insert" menu in *Word*.

3 Each card has a unique "topic name". The topic name is attached to a card by inserting a footnote just before the cards title (use the insert menu). The footnote has to use the "Custom footnote mark" option with the mark as the hash sign (#). The topic name is placed in the footnote. *The name must include no spaces.* **To use the *Map Maker* system one of your topic names must be "Contents".**

4 From any point in any card you can make a link to another card. To do this you first need to create a "hot spot". A hot spot is a word or words in the text which when clicked on with the mouse will cause the jump to be executed. In your text highlight the desired word or words and select "Double underline" from the character option from the format menu. This double underlined text will appear as green underlined text in the final help system. Now *immediately* after the double underlined text, with *no spaces*, type in the topic name of one of your cards. Then highlight this text and select "hidden" as the character option. *(Note: it makes life easier if under "Tools-options" you opt to at least show hidden text if not "all" control characters.)*

The above four steps are all that you need do to create your hypertext system. Using *Microsoft Word* you can edit the text including all the normal features of bold text, italics, different fonts etc., though you should be careful not to include any unusual fonts which may not be on the computers which will be using the system. Also using "Insert-picture" or "Insert-frame" you can include pictures in your hypertext. In addition, there are some further enhancements which hypertext offers:

5 Immediately after the footnote for the topic name (see step 3 above) you can include a second footnote using the dollar sign ($) as the footnote mark. The contents of the footnote will then become the "Title" of the card. Spaces may be included in the title.

6 Also after the topic name footnote you can use footnotes to include one or more keywords using the letter K as the footnote mark. These keywords can then be used by the "search" mechanism in the help system. One keyword can be attached to several cards. When that keyword is used for a search the titles of all those cards will be listed.

7 If you define your hot spot with a single underline instead of a double underline in the final help system this text will appear with a dotted underline. When you click on this instead of moving entirely to the card to which the link points it will display a pop-up window which disappears when you click the mouse and returns you to the screen you were at. These pop-up cards cannot have scrolling text so their contents must be short. Also they should not contain hot spots to other cards. They are mainly used for dictionary type definitions of terms.

8 You can create a style within *Word* which might be called Title, for instance, which you can apply to the first line of each card. If this style is defined through "format-paragraph" to "Keep lines together" and "Keep with next", then in the help system this title will stay at the top of the screen while the text below can be scrolled.

Appendix 1 Specification of DRA files

Drawing files are binary files describing graphic objects. Each object type is identified by a code. In the current version (version 2), the available codes are:

0 Null (deleted object)
1 Line
2 Polygon
3 Point
4 Text
5 Arrow

8 File header
11 Value

20 Node
21 Link

An object can consists of three parts: Object header, Attribute record, and Geometry records

Object type	Object header	Attribute record	Geometry records
1. Line	x	x	N
2. Polygon	x	x	N
3. Point	x	x	2
4. Text	x	x	N
5. Arrow	x	x	2
8. File header	x		
9. Embedded file	x	x	
11. Value	x	x	
21. Node	x	x	2
22. Link	x	x	N

Every object starts with a 24 byte header of the following form:

Offset	Size in bytes	Content
0	1	signature byte, always equal to 237 + version number
1	1	object type, value as decribed above
2	4	a 32 bit integer describing the total object size in bytes
6	4	rounded down Minimum X x 100 as 32 bit integer
10	4	rounded down Minimum Y x 100 as 32 bit integer
14	4	rounded up Maximum X x 100 as 32 bit integer
18	4	rounded up Maximum Y x 100 as 32 bit integer

22	2	size as a word in bytes of the atrribute record or in file headers and group headers this value gives the number of objects that it contains

In versions earlier than version 2, the minimum and maximum XY values are not multipled by 100.

After the object header there is an attribute record. After the attribute record there follows a number of 13-byte geometry records each of the form:

Offset	Size in bytes	Content
0	12	geometry data
12	1	attribute flag if bit 3 is set the line is a curve until the next stored node if bit 4 is set the point is a stored node if bit 5 is set the point is the start of a satellite island if bit 6 is set the geometry data contains label data if bit 7 is set then the point is the start of an island

The contents of the geometry data depends on the value of bits of the attribute flag.

Flag bits	Offset	Content
bit 6 = 0	0	X ordinate as six-byte real
	6	Y ordinate as six-byte real
bit 6 = 1	0	Label X offset x 100 as 4 byte integer (horizontal distance in metres from the geometrical centre of the bounding box, positive to the right of centre)
	4	Label Y offset x 100 as 4 byte integer (vertical distance in metres from the geometrical centre of the bounding box, positive up from centre)
	8	Label rotation (anti-clockwise) in tenths of a degree as two byte integer
	10	Justification code 0 = left justified 1 = centre justified 2 = right justified
	11	Text scaling factor as percentage (the size of the font is multiplied by this factor/100

Some attribute records contain a *Caption record*:

Offset	Size in bytes	Content
0	1	size byte, N1
1 (if N1<255)	N1	caption
1 (if N1=255)	2	size as a two byte word, N2

3	N2	caption
3+N2	1	terminating character, must be zero

The attribute records vary with the different object types:

Line, polygon, link, and node polygon attribute record

Offset	Size in bytes	Content
0	1	display style
1	1	attribute flag if bit 0 is set then free-form curves are used if bit 1 is set the polygon contains stored nodes if bit 7 is set the polygon contains islands
2	8	Eight byte data block In a link object this block contains two four-byte integers corresponding to the identifiers of the nodes at the ends of the link. In lines and polygons this block is empty.
10	N1	Caption record (see above)
10+N1	1	Size in bytes of object ID - N2
11+N1	N2	object's Unique ID as a string

After the header there follows a number of geometry records, calculated from the object size and the attribute size (ie number of geometry records = (object size - attribute size)/13). From version 1 the first geometry record is the label data (attribute flag = 64).

Point and node attribute record

Offset	Size in bytes	Content
0	1	display style
1	1	attribute flag
2	8	Eight byte data block In node object the first four bytes are an integer which is the unique identifier of the node.
10	1	Label location code (spare from version 1)
11	N1	Caption record (see above)
11+N1	1	Size in bytes of object ID - N2
12+N1	N2	object's Unique ID as a string

After a point attribute record there is a geometry record giving the XY value. From version 1 there is a second geometry record containing the label data (attribute flag = 64).

Text attribute record

Offset	Size in bytes	Content
0	1	display style

1	1	attribute flag
2	1	justification code
3	6	Text height in metres on the ground as a six-byte real
9	2	Rotation in tenths of a degree as a two-byte integer
11	N1	Caption record (see above)

The number of geometry records varies with the justification code:

Justification code	Number of geometry records	Description of type
0	1	Left justified text
1	1	Right justified text
2	1	Centre justified text
3	2	Stretched text
4	3	Curved text. The first two XY pairs contain the ends of the text, the X value of the third contins the deflection from the straight line between the two ends.
5	4	Bezier curve. The XY pairs contain the control points.

Arrow attribute record

Offset	Size in bytes	Content
0	1	display style
1	1	attribute flag
2	1	spare
3	N1	Caption record (see above)

There follows two geometry records. The first XY pair locates the point of the arrow, the second is the control point for the caption.

Value attribute record

A value object is used to store a user-defined numerical value in specialist applications. Typically this may be used for storing a height datum.

Offset	Size in bytes	Content
0	6	data value as a six-byte real
6	2	spare

Appendix 2. Specification of SFC files

Data Surface files (SFC) contain the definition of a grid of square cells where a point value is stored for each interstice. It is like a digital terrain model (DTM). It starts with a header:

Offset	Size in bytes	Content
0	1	actual length of name (max 39)
1	39	name
40	6	X ordinate of left edge of grid (real)
46	6	Y ordinate of bottom edge of grid (real)
52	6	Width of each grid cell (real)
58	2	Number of cells in X direction (integer)
60	2	Number of cells in Y direction (integer)

After the header the rest of the file is taken up with 11-byte data records arranged in rows progressing left to right and bottom to top. Each row contains one more data record than the number of cells in the X direction in order to account for the final grid line. Similarly there is one more row than the number of cells in the Y direction. Each data record contains:

Offset	Size in bytes	Content
0	6	data value as a six-byte real
6	1	confidence value (how good is the data)
7	4	reserved